Introduction to Bowtie Methodology for a Laboratory Setting

ACS 251st National Meeting

Division of Chemical Health and Safety

Developing, Implementing & Teaching Hazard Assessment Tools

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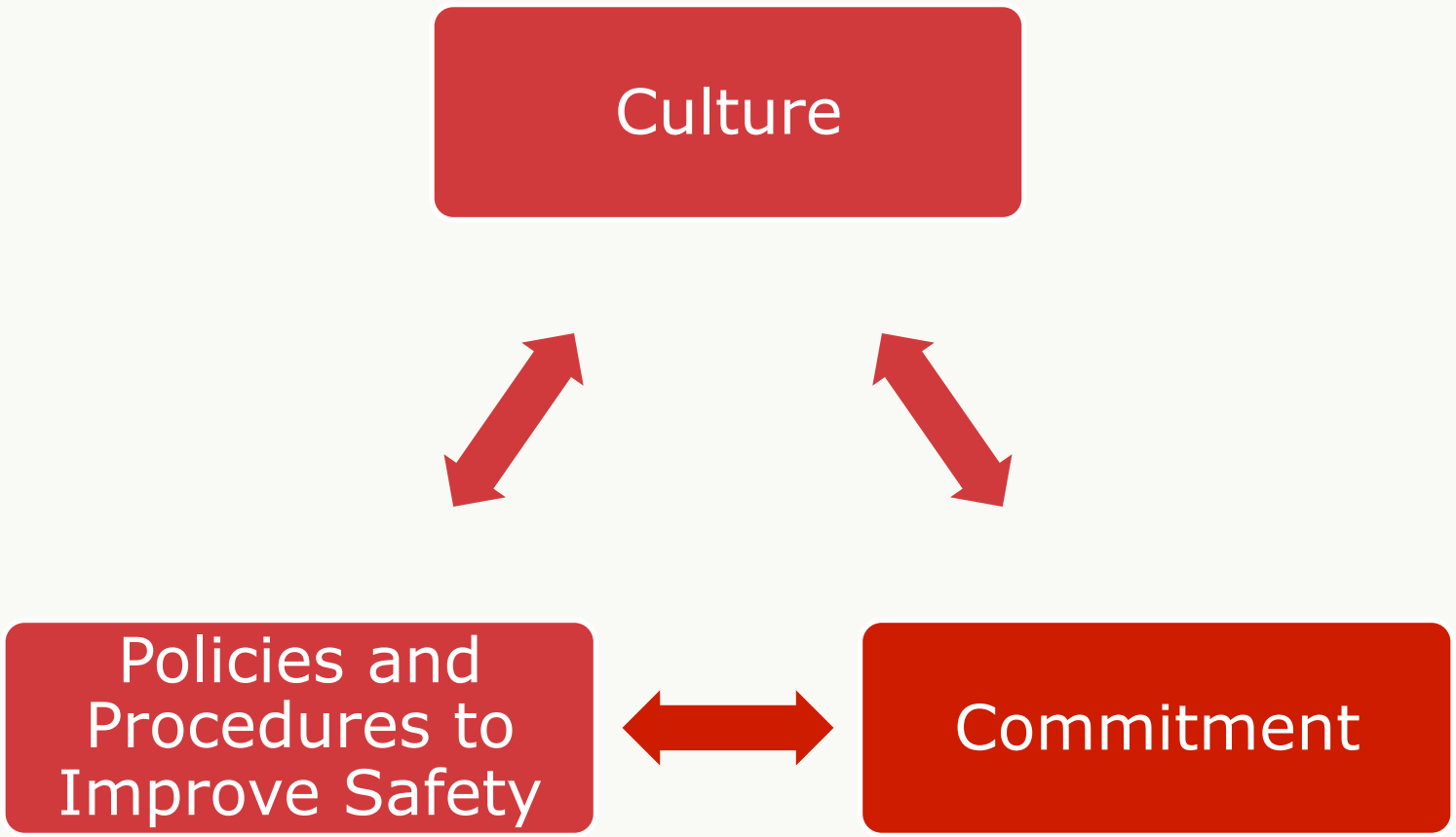
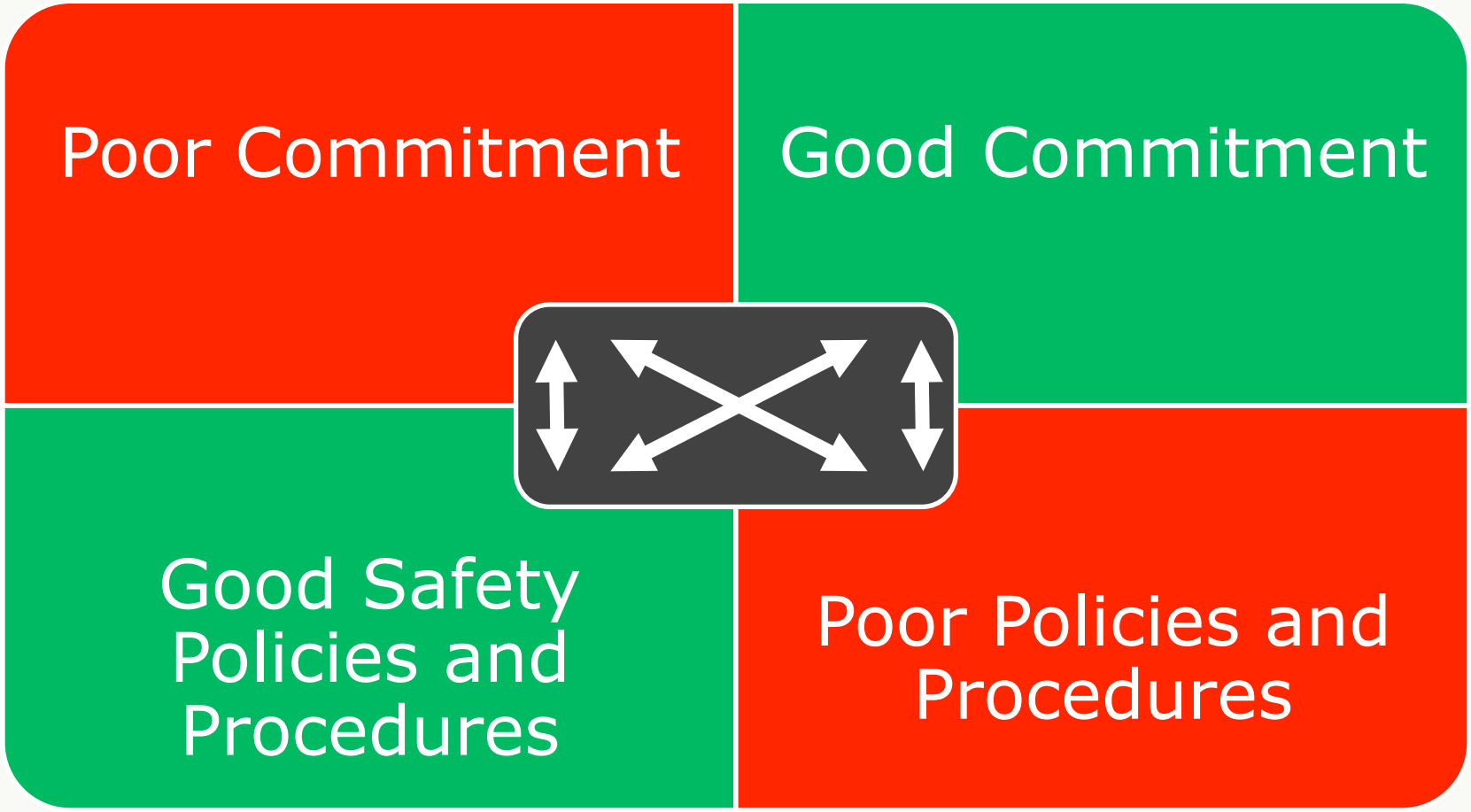
15 March 2016

SAFER, SMARTER, GREENER

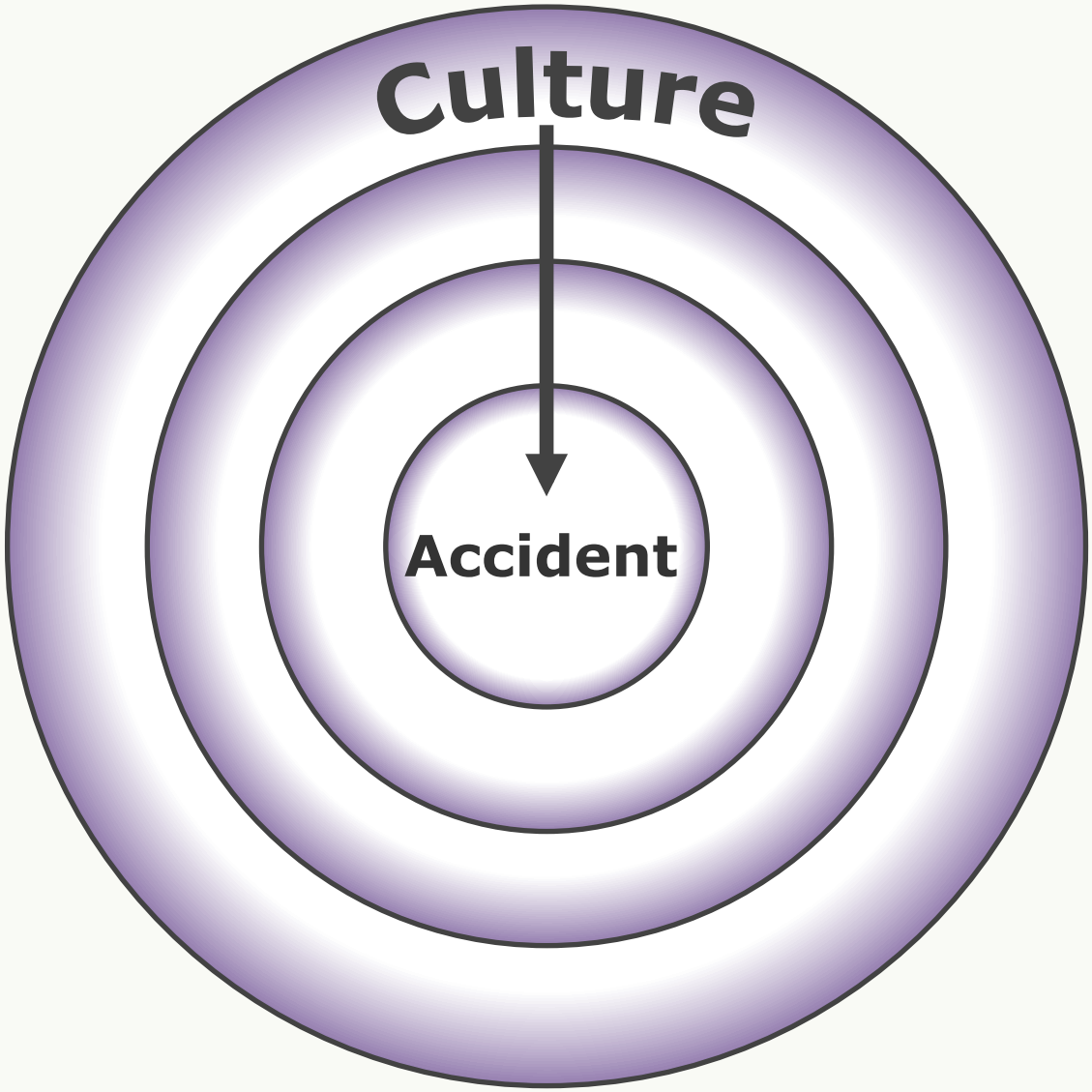

Culture
Accident

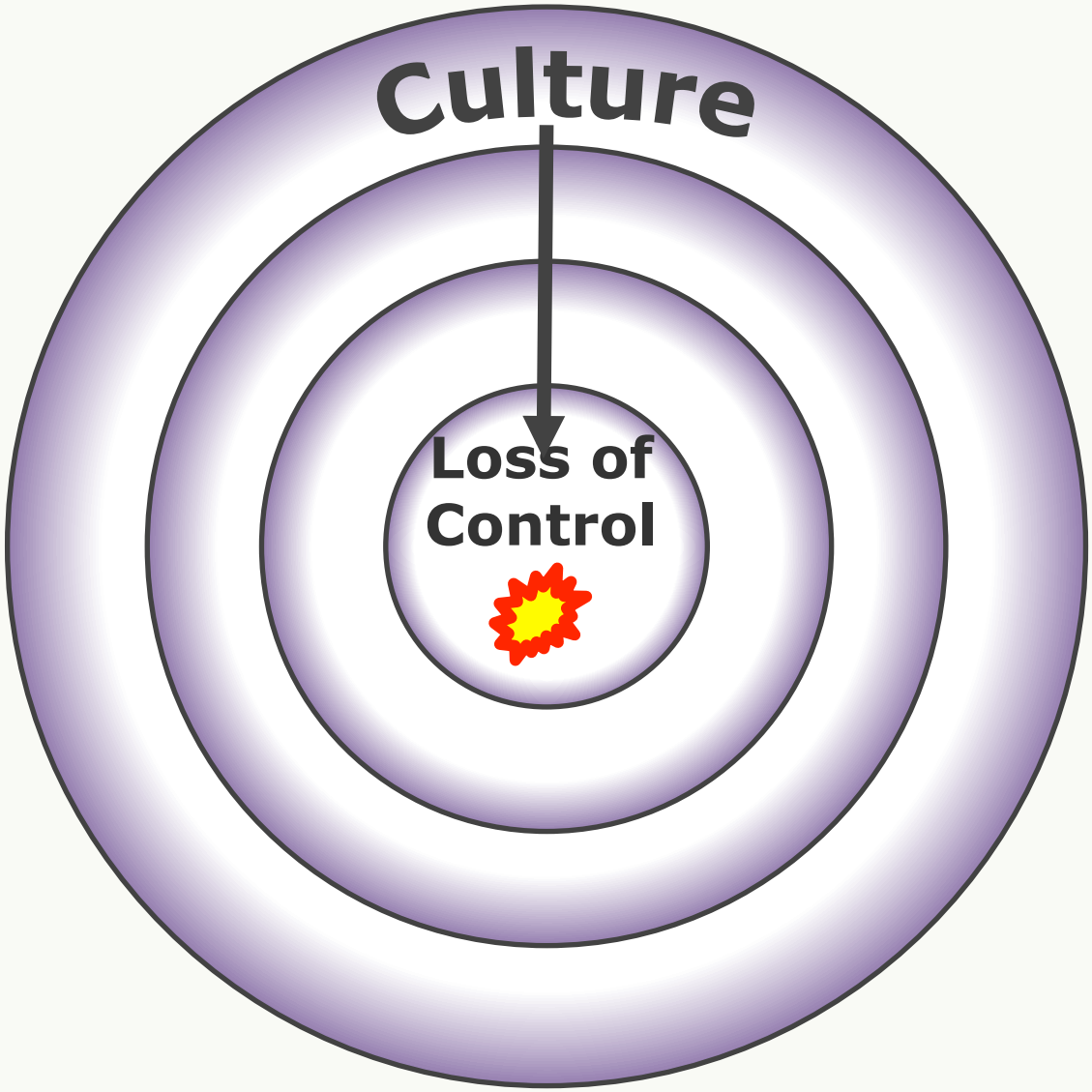

Culture
Policies and Procedures to Improve Safety
Commitment

Safety Culture

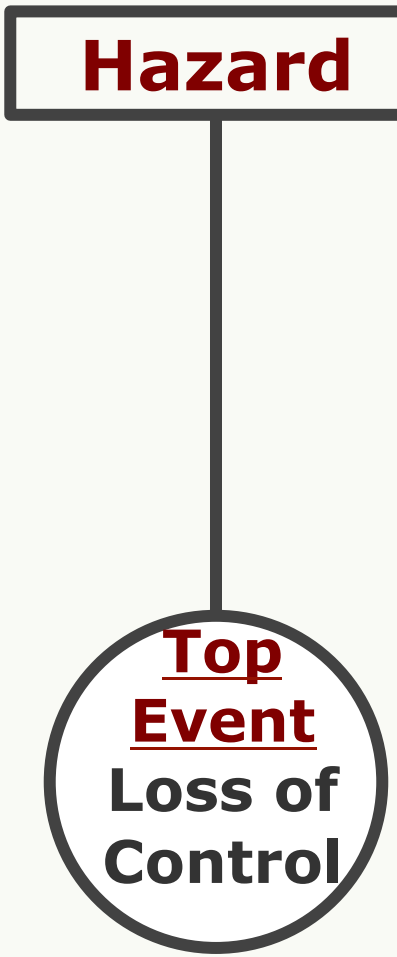


Safety Culture


Culture
Accident


Culture
Loss of Control

Hazard/Top Event



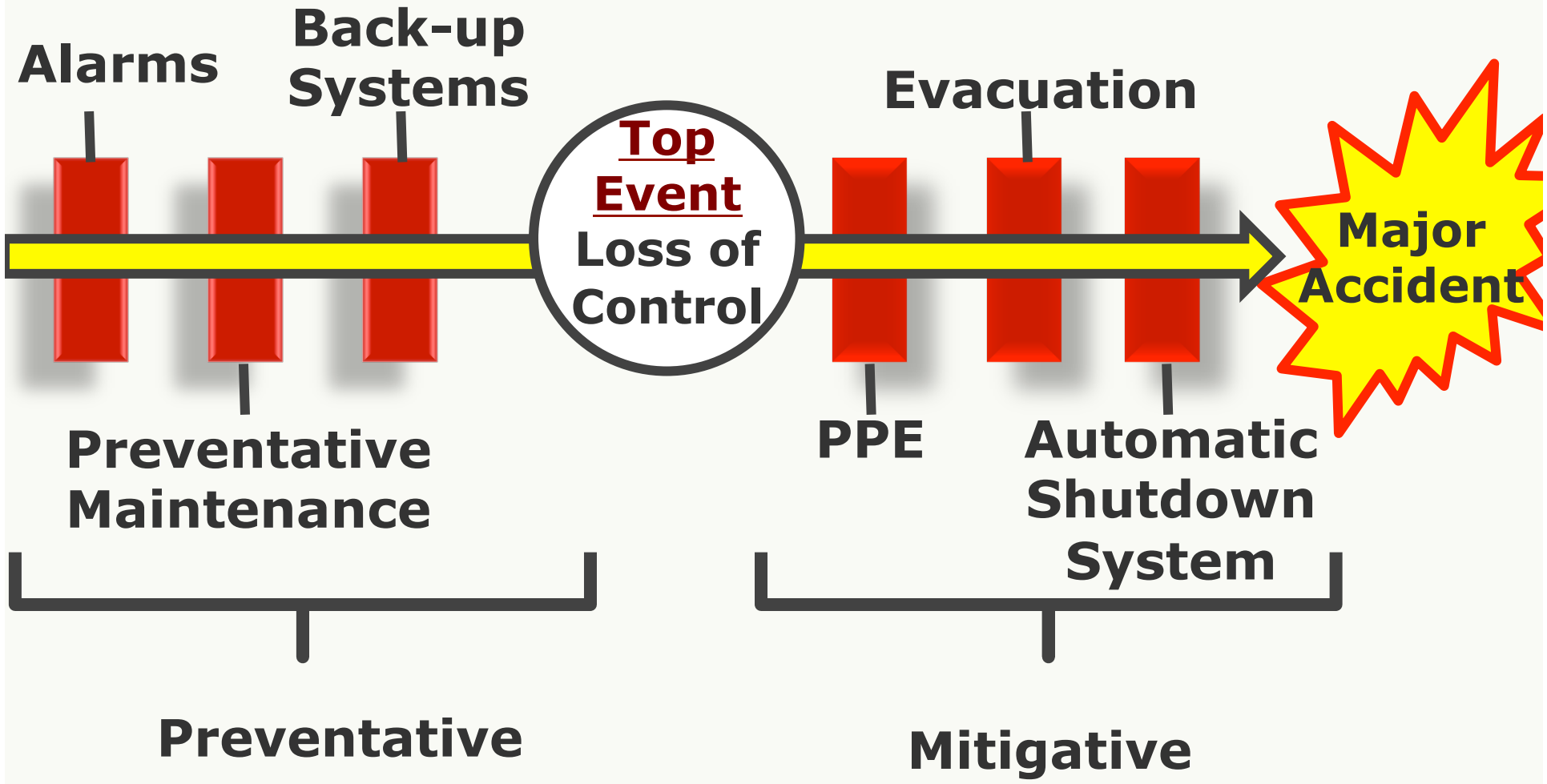
- Health Hazard (carcinogen, toxin, etc.)
- Physical Hazard (flammable, explosive, etc.)

When do you have to change your response?

- Threshold amount
- Loss of containment
- Loss of utilities

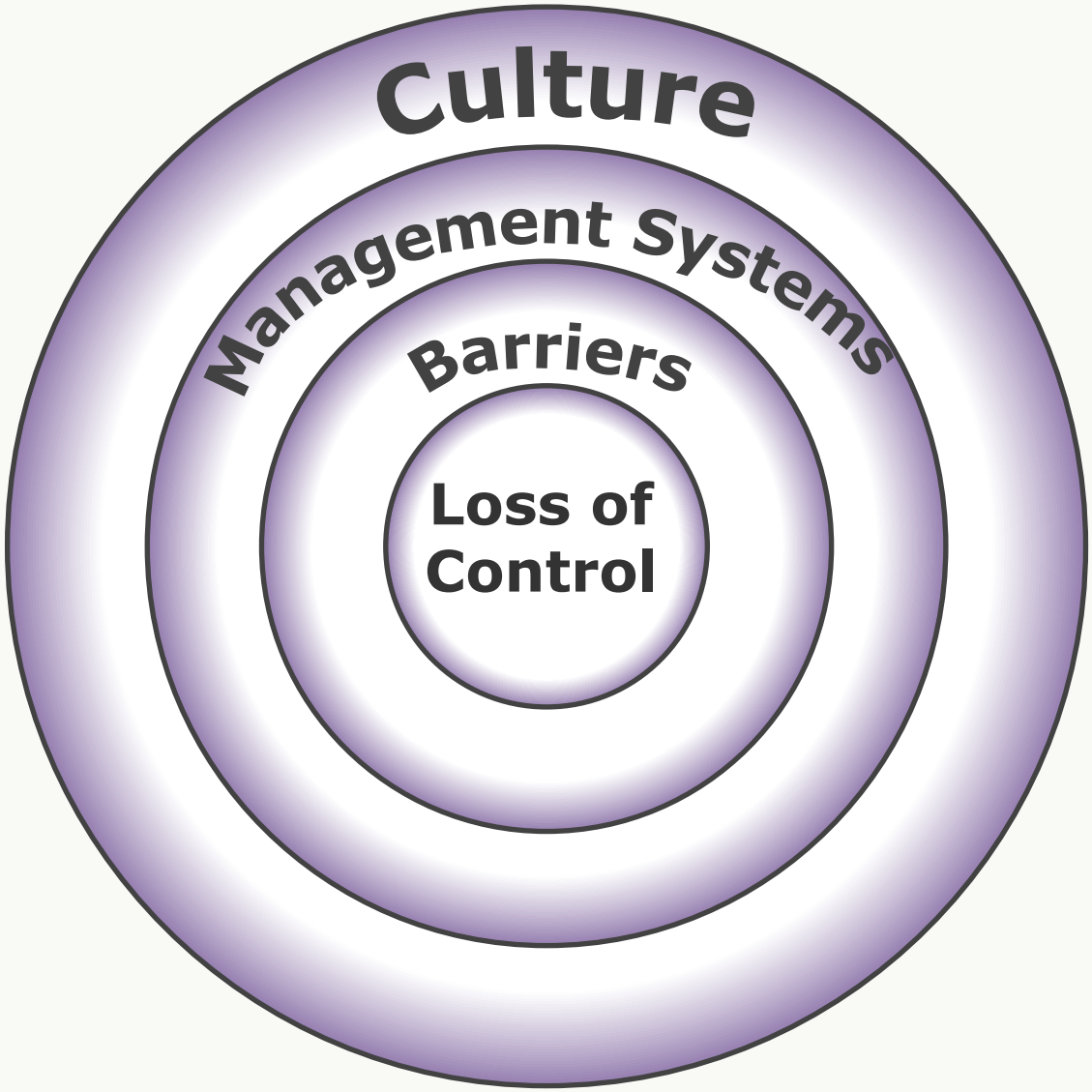
Barriers

Barriers


Alarms
Back-up Systems
Top Event
Loss of Control
Evacuation
Major Accident
Preventative Maintenance
PPE
Automatic Shutdown System
Preventative
Mitigative

Management Systems

- Hazard Identification
- Procedures
- Incident Investigations
- Indicators


Culture
Management Systems
Barriers
Loss of Control

About DNV GL

150
years

350
offices

100
countries

16,000
employees

DNV GL Organization

MARITIME

OIL & GAS

ENERGY

BUSINESS ASSURANCE

SOFTWARE

MARINE CYBERNETICS

RESEARCH & INNOVATION

Together we will cover

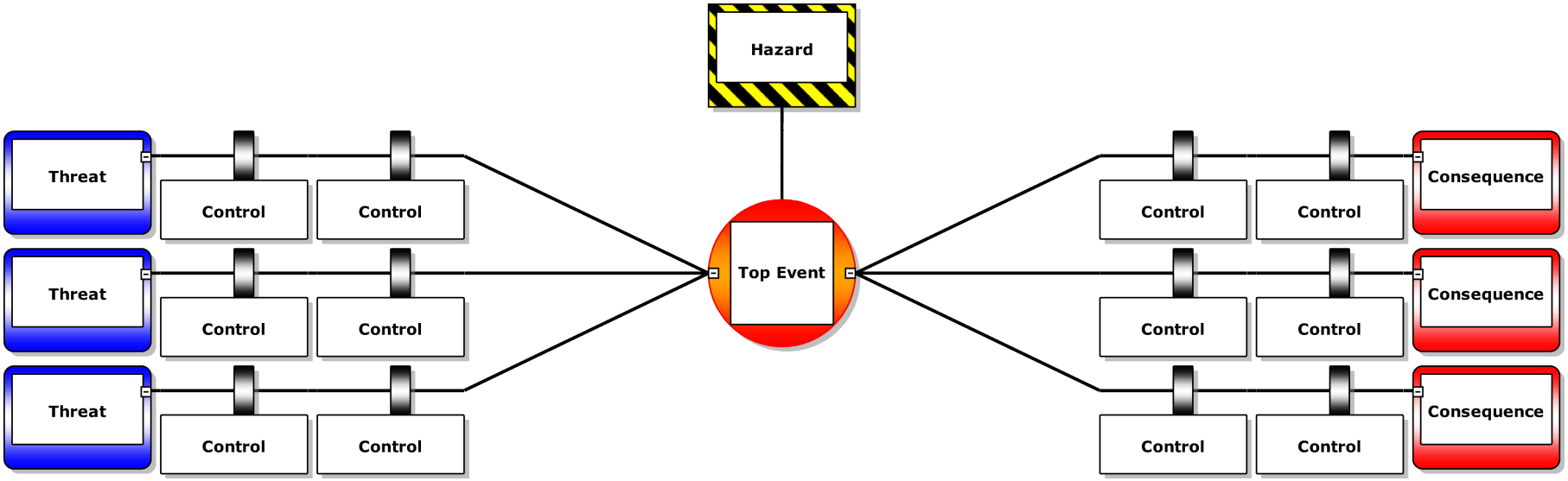
2:30pm - Overview of Bowtie

3pm-5:30pm - Workshop

- Basic principles
- Best practices (do’s and don’ts)
- Plenary and group exercises – develop bowties
- Link to organizational and safety culture

What is a bowtie, and how can it be used?

Excellent communication tool



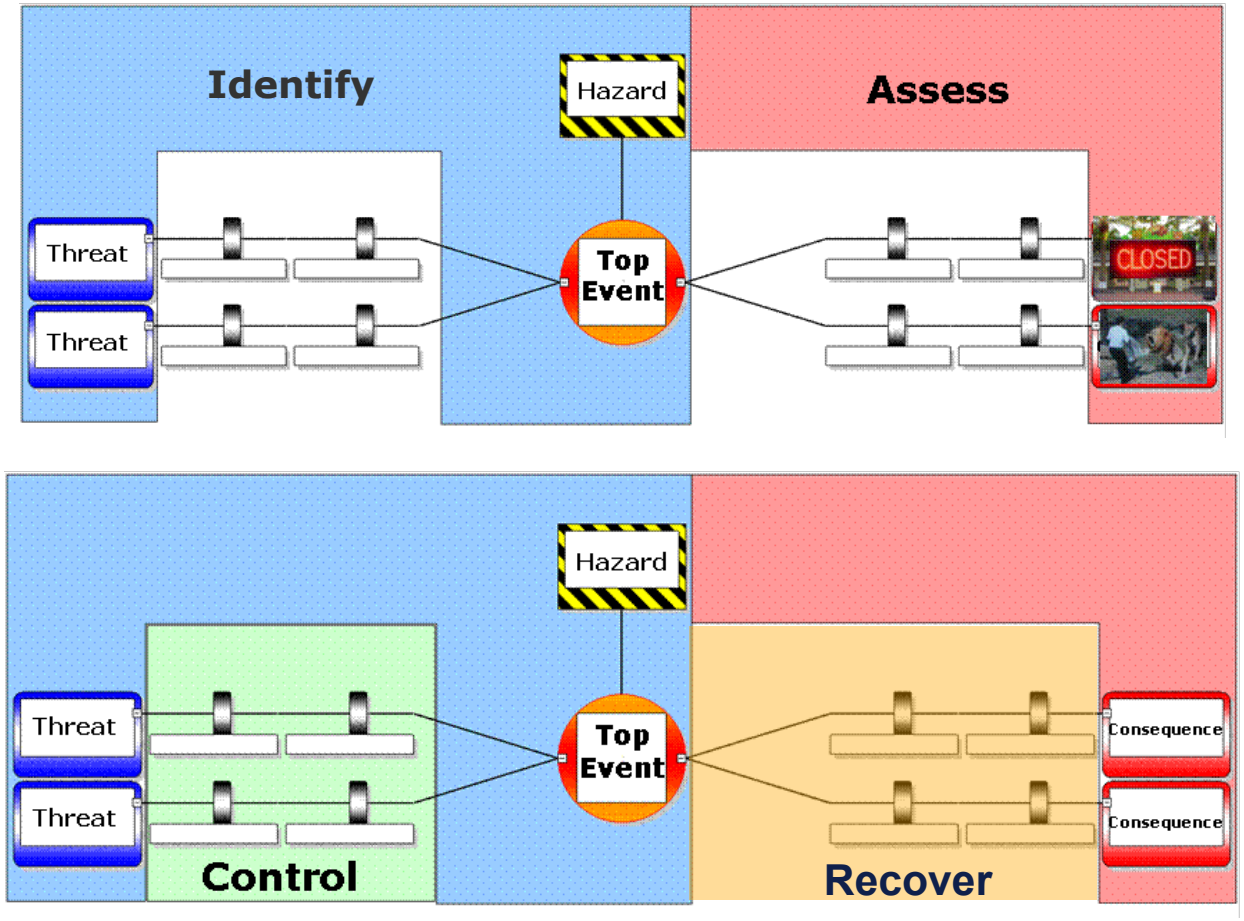
Not good for hazard identification

Bowtie Risk Process

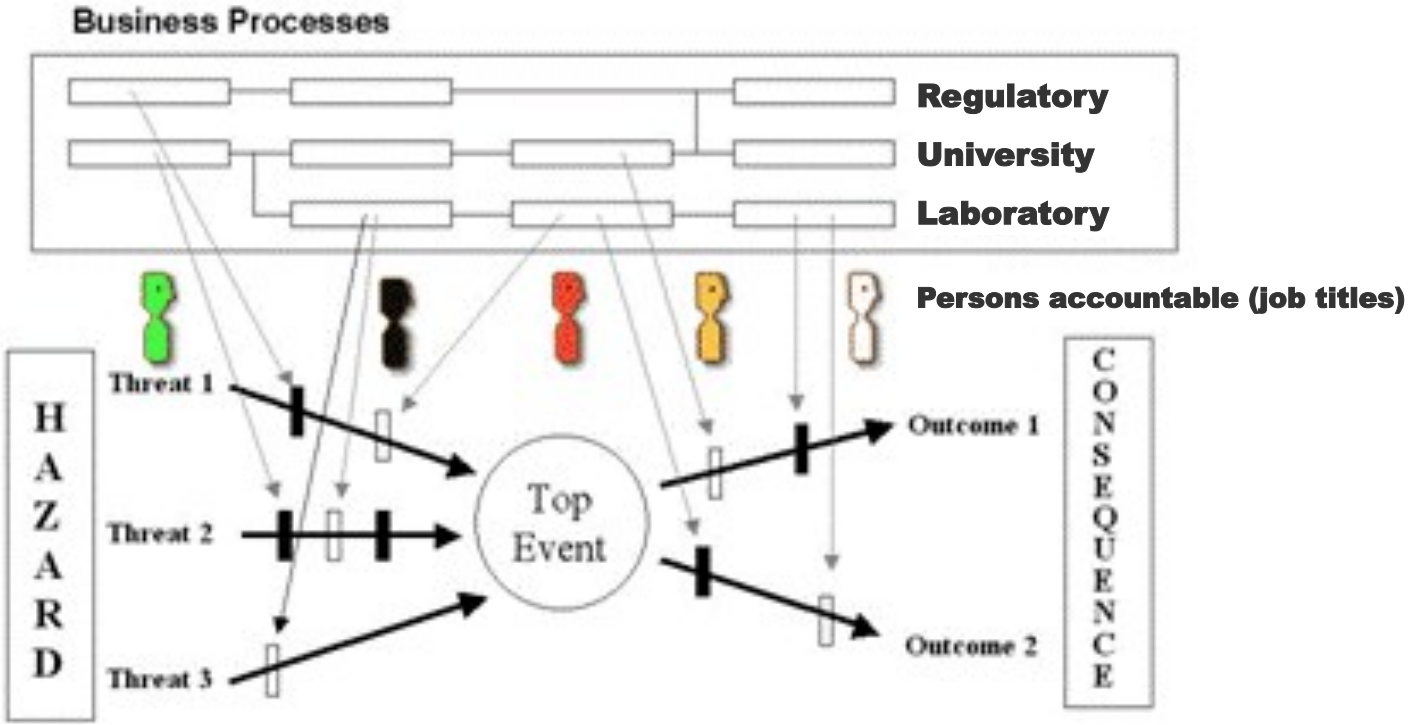
Identify – Assess – Control – Recover

Identify and Assess

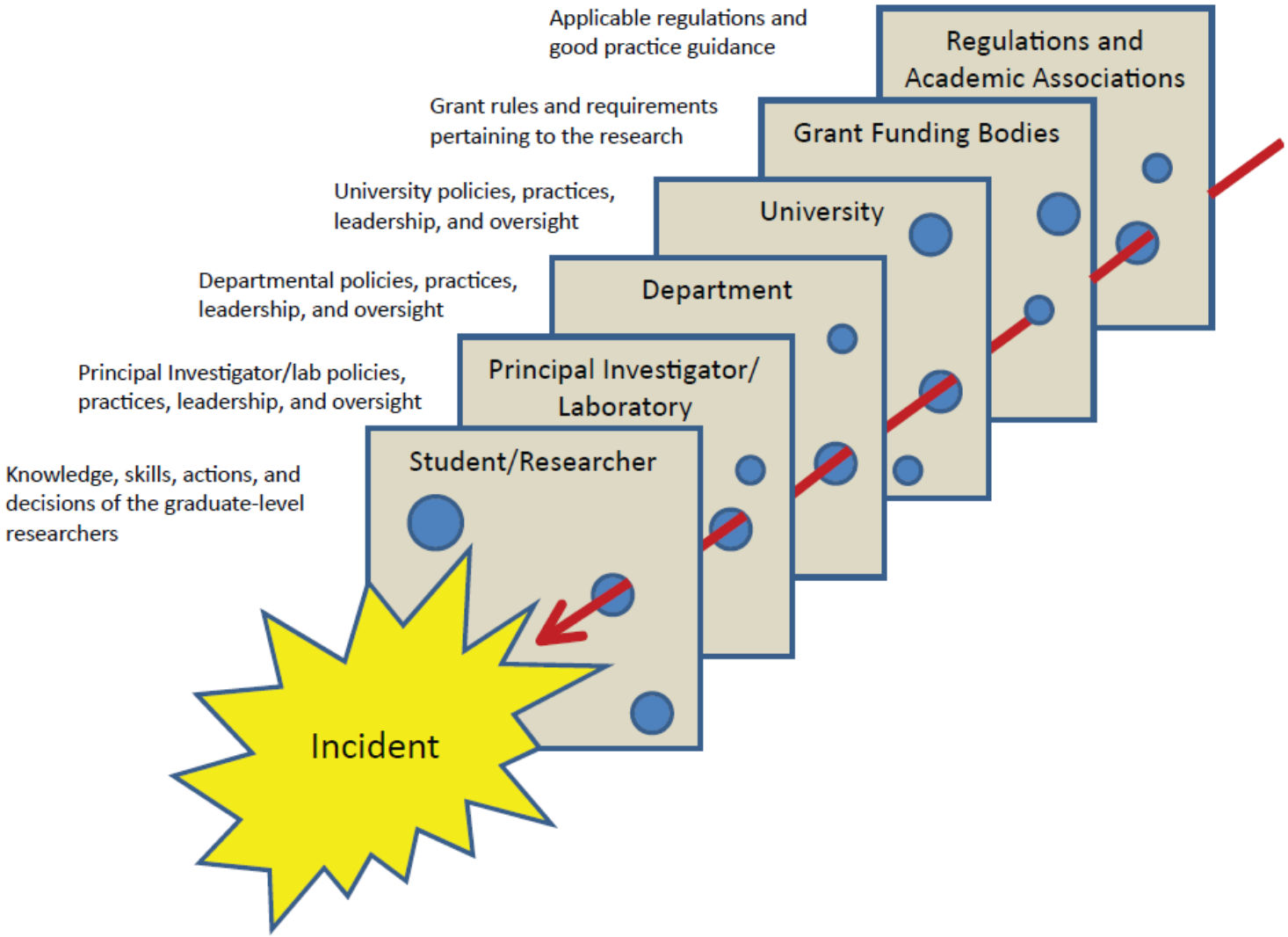
Control and Recover



Bowties link physical controls to your management system



Accident Causation Model – James Reason



Bowties – Brief History

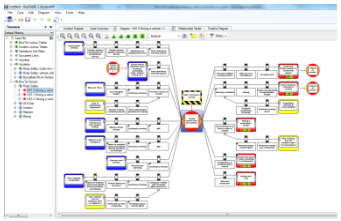
1979

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

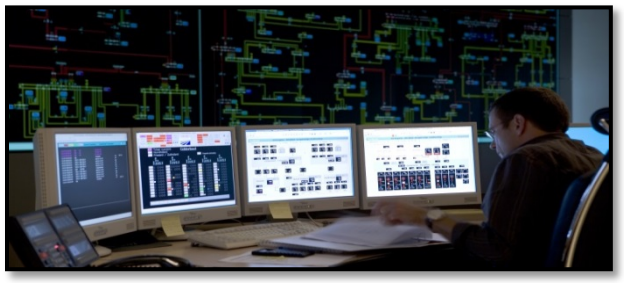
1988

1990s

2000s



2016



Bowties - History

- It is said that the first 'real' Bowtie diagrams appeared in the (Imperial Chemistry Industry) course notes of a lecture on HAZAN (Hazard Analysis) given at The University of Queensland, Australia (in 1979), but how and when the method found its exact origin is not completely clear.

- The catastrophic incident on the Piper Alpha platform in 1988 awoke the oil & gas industry. After the report of Lord Cullen, who concluded that there was far too little understanding of Hazards and their accompanying risks that are part of operations, the urge rose to gain more insight in the causality of seemingly independent events and conditions and to develop a systematic/systemic way of assuring Barrier over these Hazards.

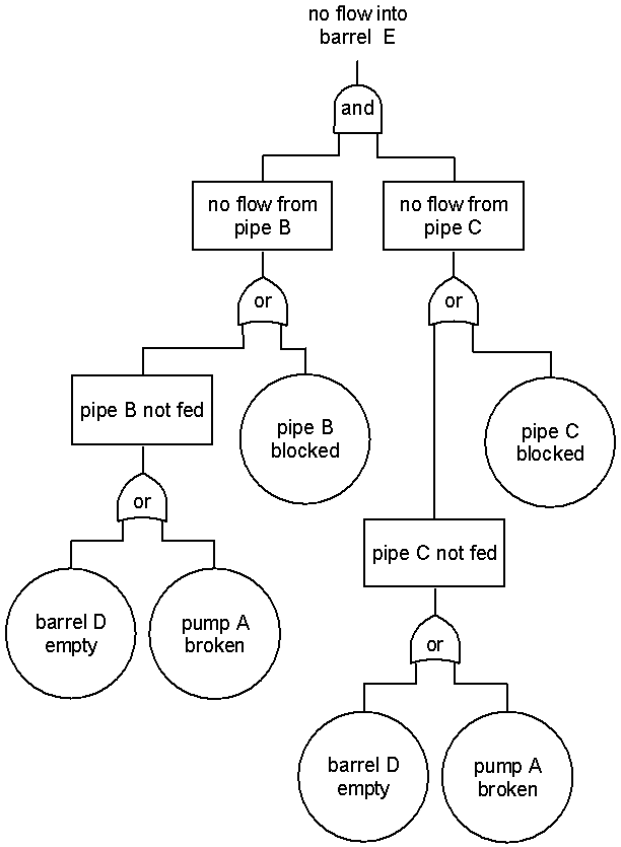
- In the early nineties the Royal Dutch / Shell Group adopted the Bowtie method as company standard for analysing and managing risks. Shell facilitated extensive research in the application of the Bowtie method and developed a strict rule set for the definition of all parts, based on their ideas of best practice. The primary motivation of Shell was the necessity of assurance that appropriate risk Barriers are consistently in place throughout all worldwide operations.

- Following Shell, the Bowtie method rapidly gained support throughout the industry, as Bowtie diagrams appeared to be a suitable visual tool to keep overview of risk management practices, rather than replacing any of the commonly used systems.

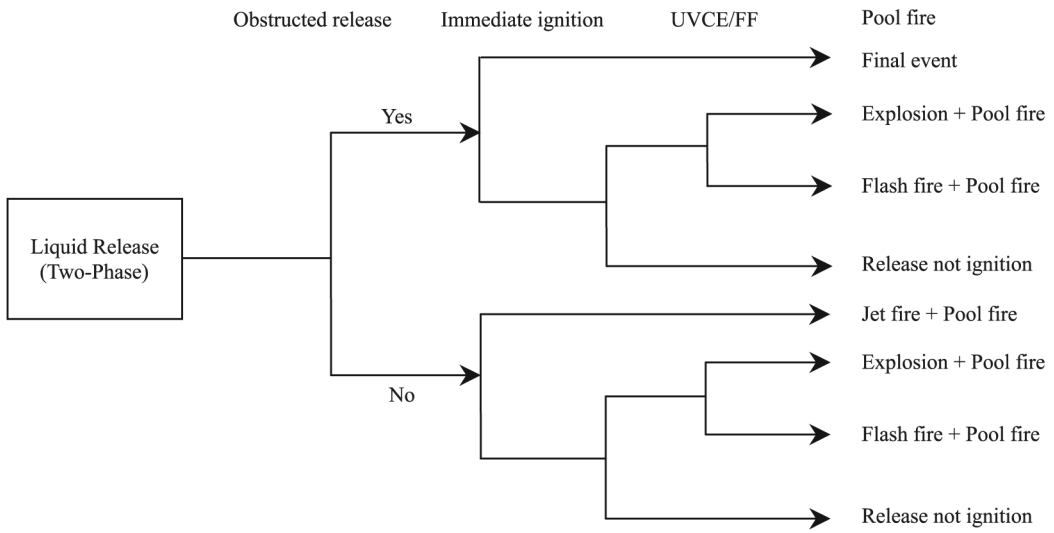
- In the last decade the Bowtie method also spread outside of the oil & gas industry to include aviation, mining, maritime, chemical and health care to name a few.

Bowtie's parents . . .

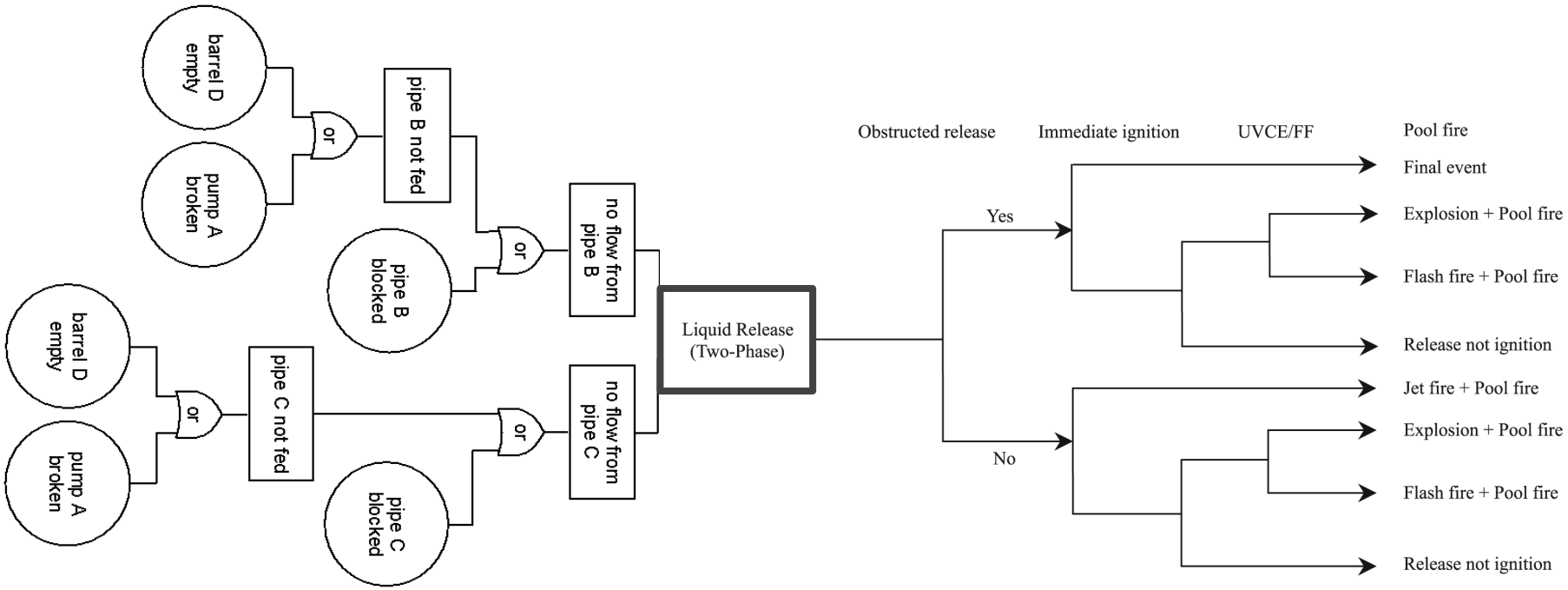
Fault tree



Event tree

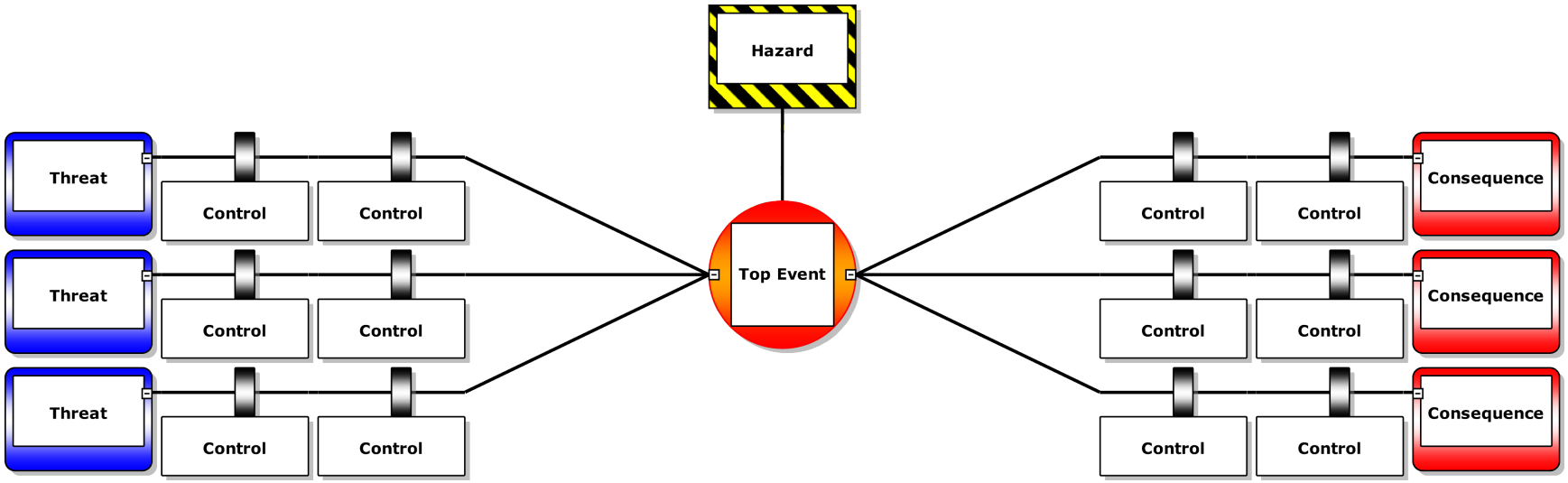


. . . Connect them



Causation Top Event Consequences

. . . Flatten them out = Bowtie

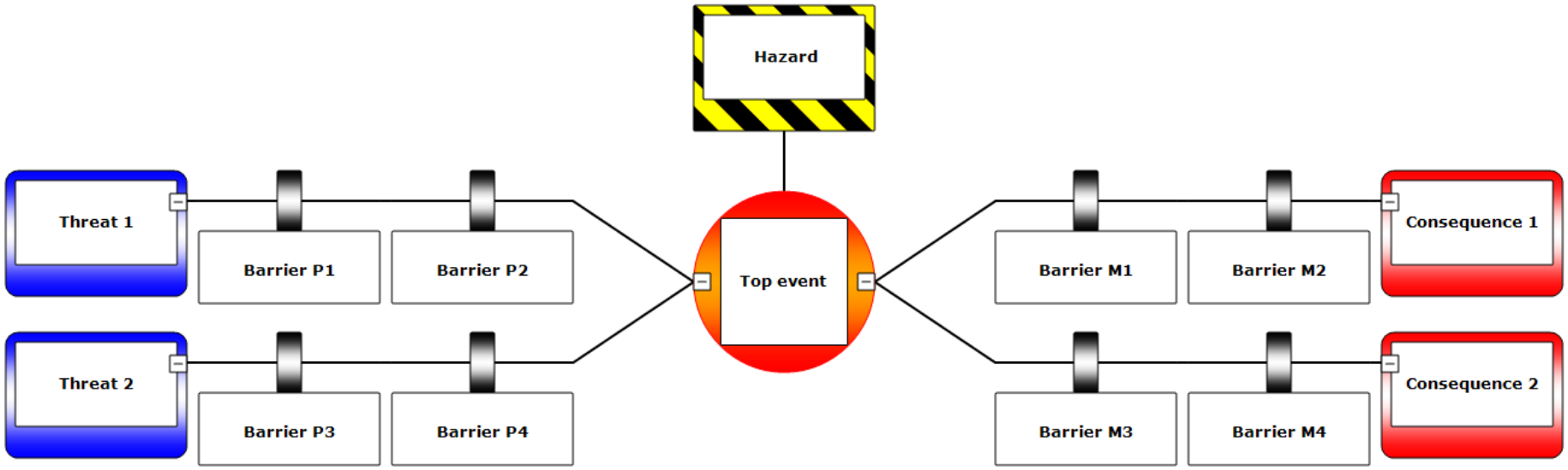


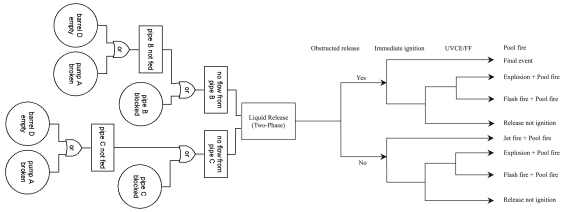
Threats ⇒ Prevention barriers ⇒ Top Event ⇒ Mitigation Barriers ⇒ Consequences

Next

- Discuss bowtie elements
- Best practices, do’s and don’ts
- Class exercise – identify the bowtie faults

Example Bowtie diagram

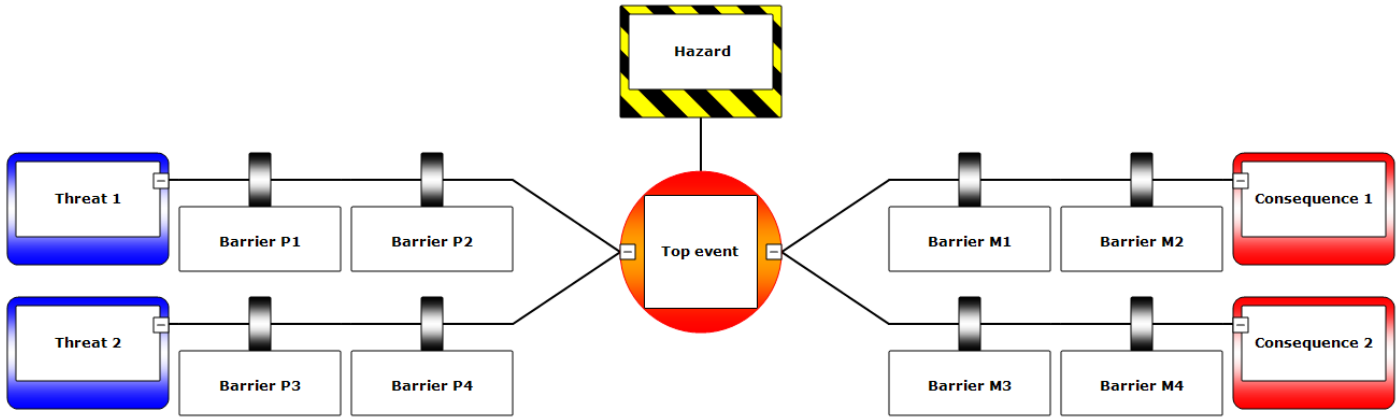




- Underpinned by Fault Tree and Event Tree methodology
- Excellent tool for hazard and risk communication
  - Simple for a diverse team to understand
    - But easy to get it wrong

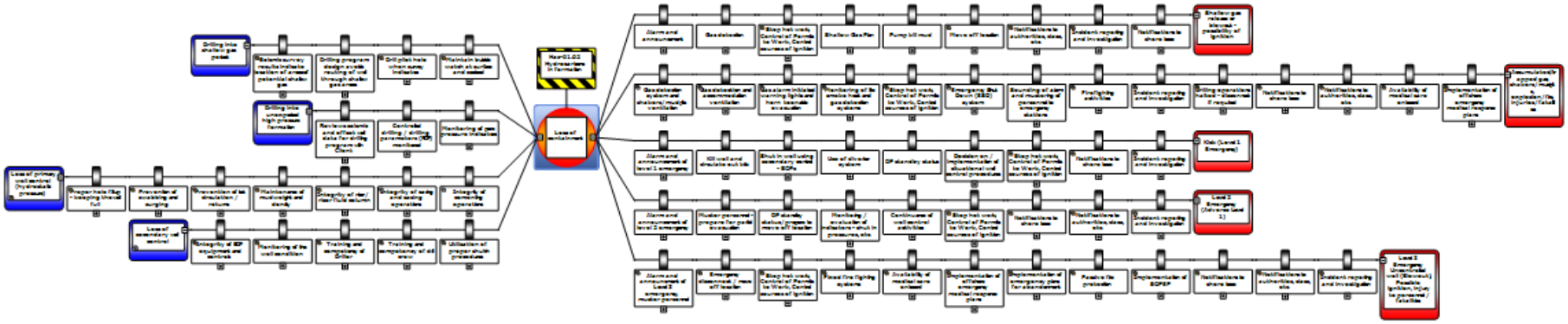
Best practices

- Construct in order:
  1. Hazard / Top Event *(most important step)*
  2. All Consequences
  3. All Threats
  4. Preventive Barriers
  5. Mitigation Barriers
  6. Escalation Factors



Example – Do's and Don'ts

ISO 17776, Haz-01.02 Hydrocarbons in Formation



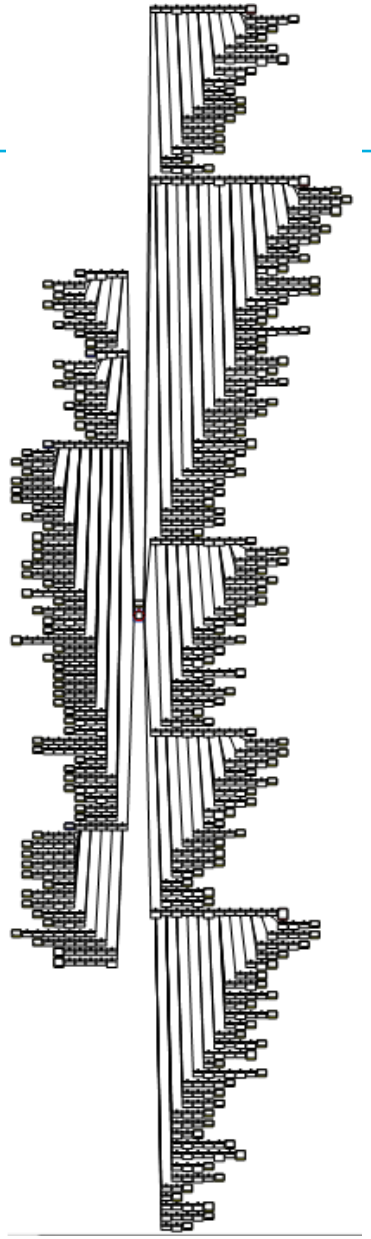
Anything wrong?

Example – Do's and Don'ts

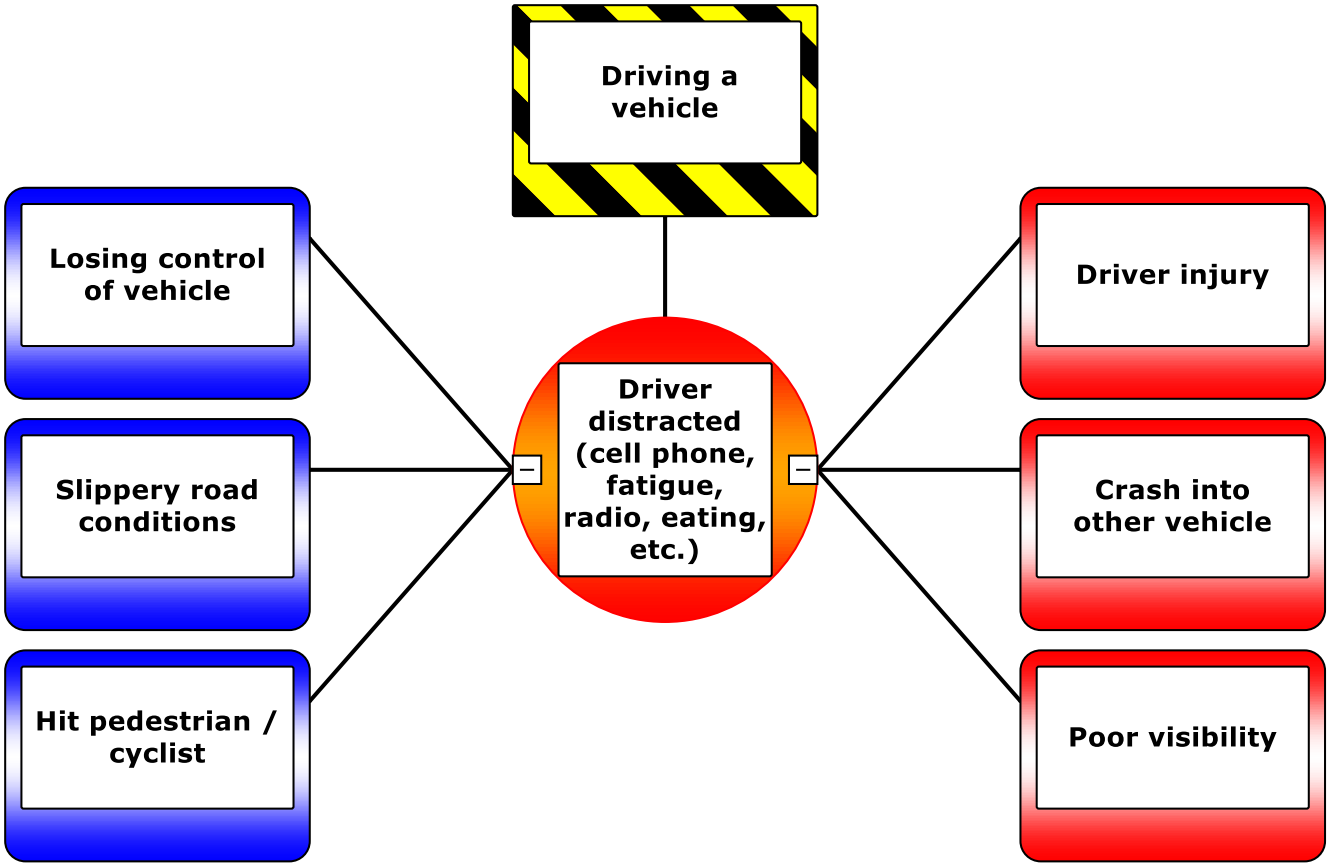
ISO 17776, Haz-01.02 Hydrocarbons in Formation (Expanded)

What are you communicating?

Who is your audience?



What's wrong with this bowtie? - Driving



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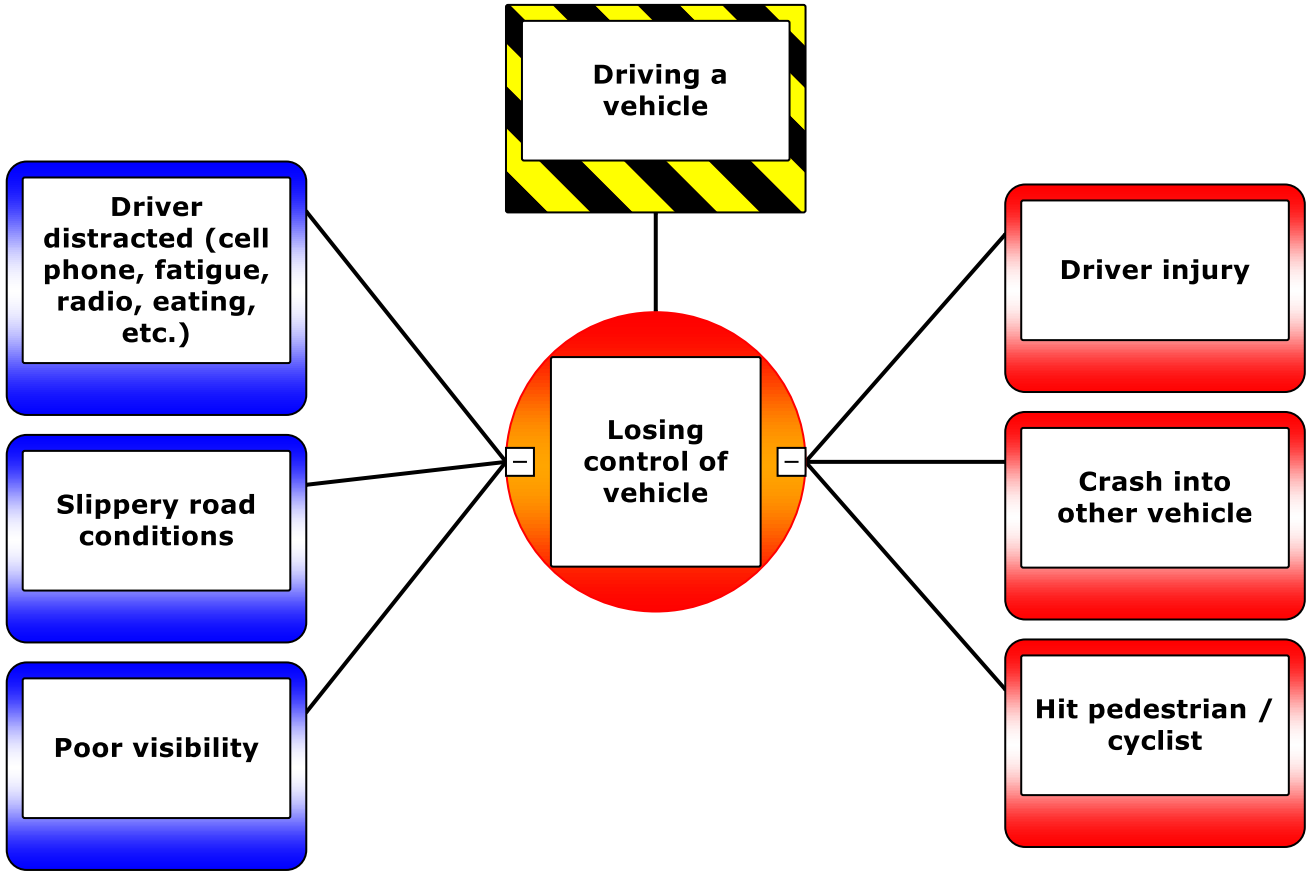
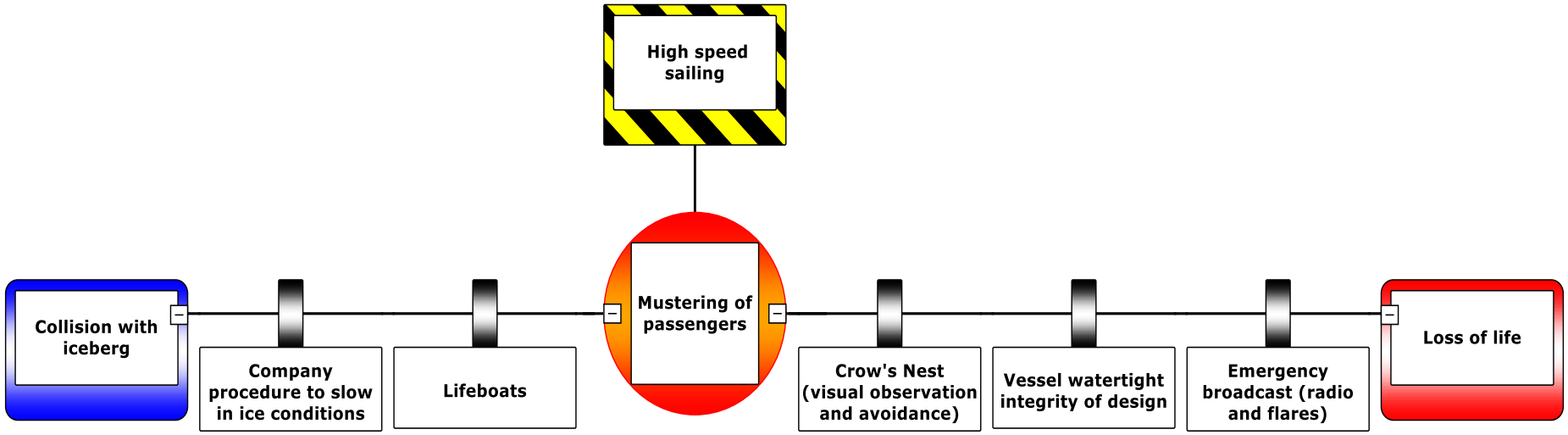


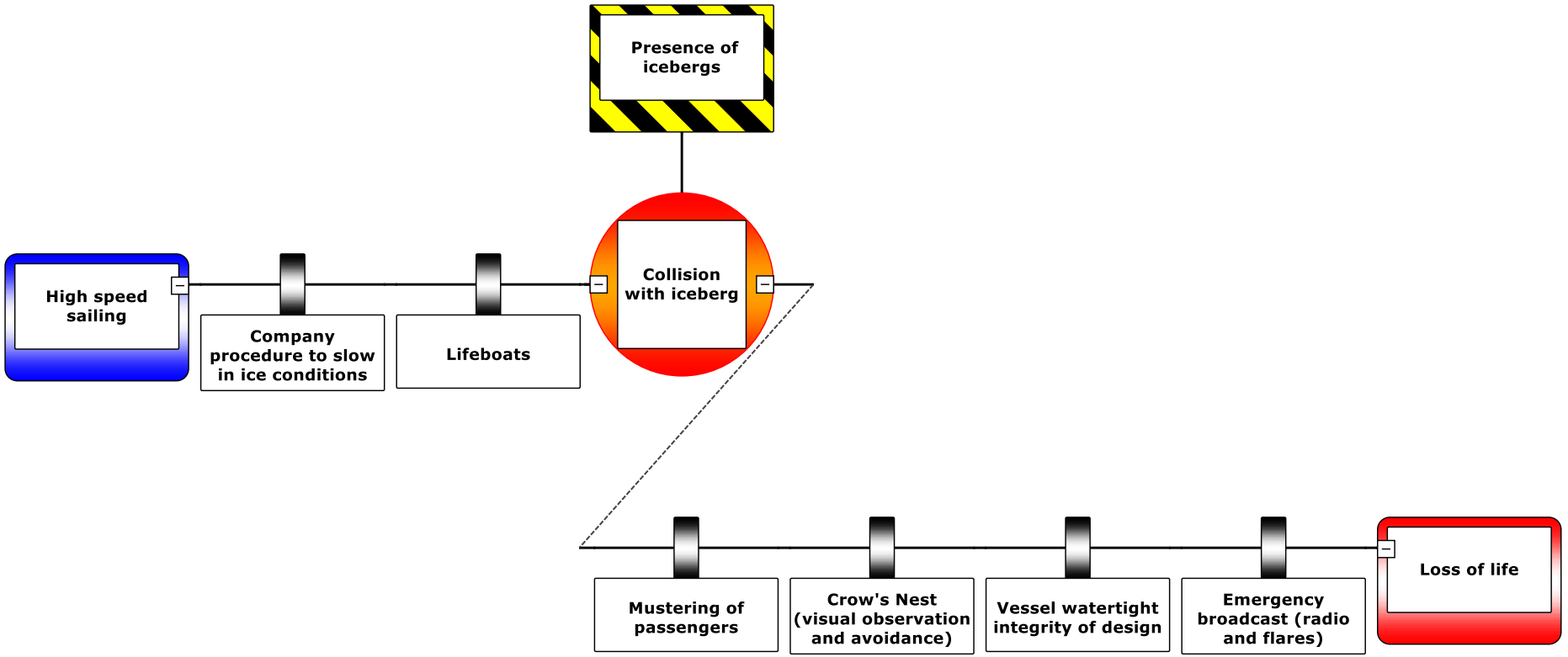
Better?

What's wrong with this bowtie? - Titanic

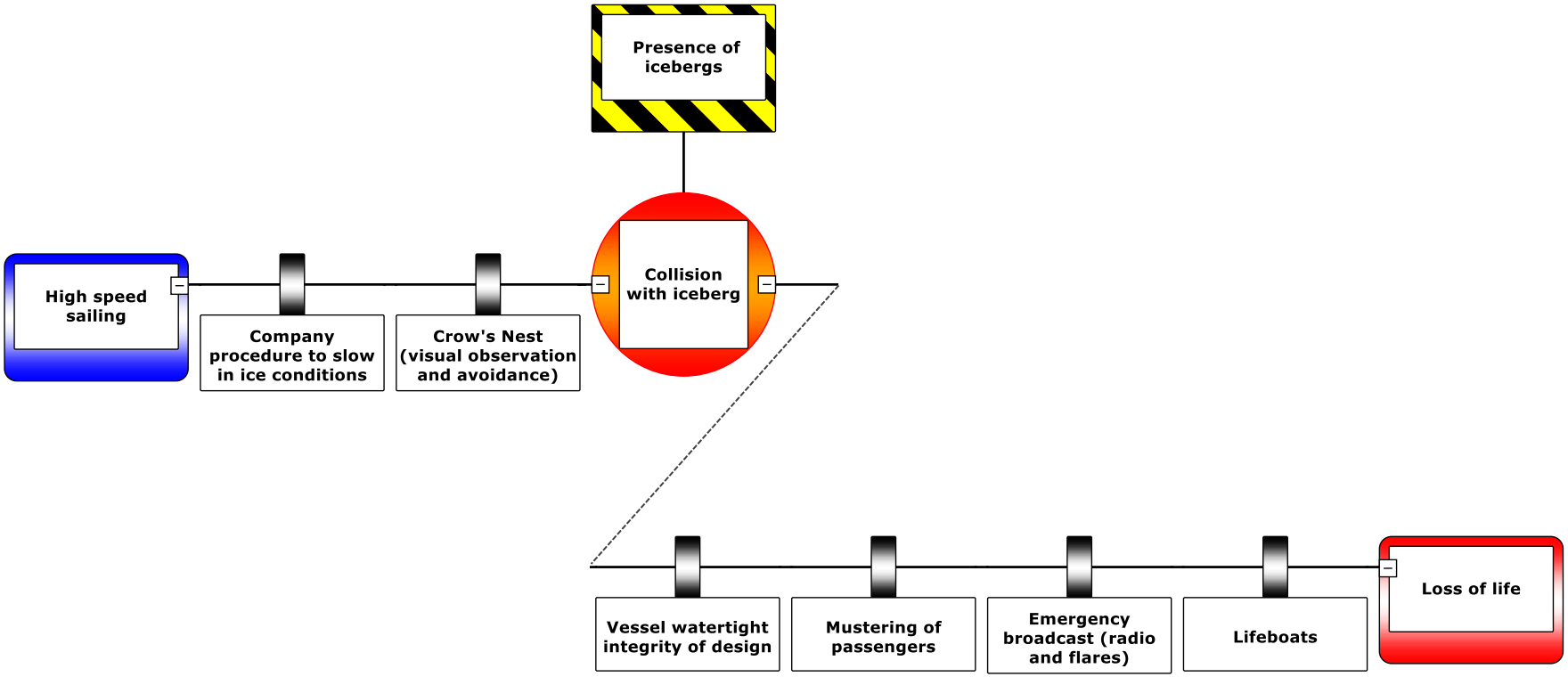


What's wrong with this bowtie? - Titanic

Hazard / Top Event are better - what about the barriers?

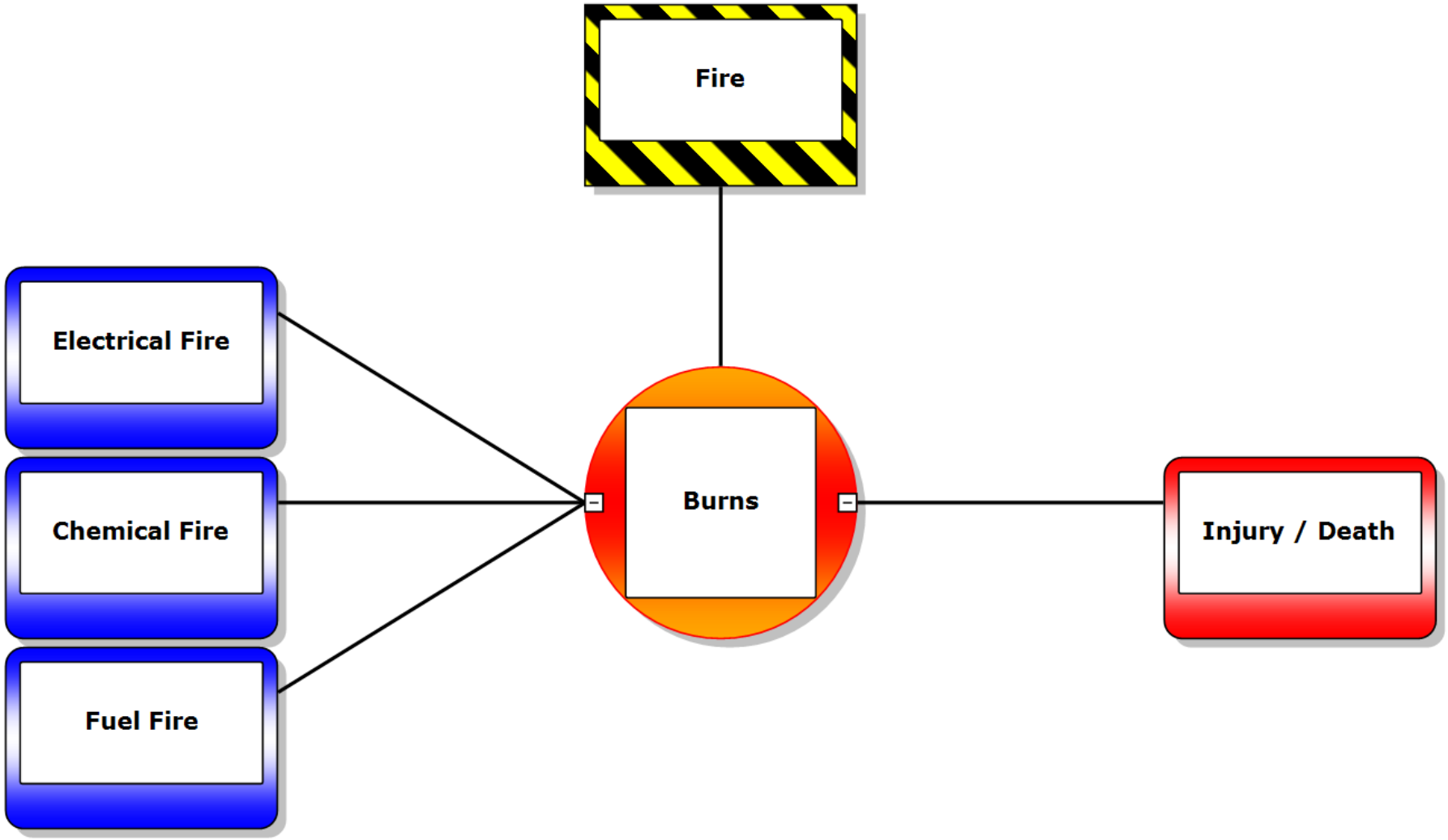


What's wrong with this bowtie? - Titanic

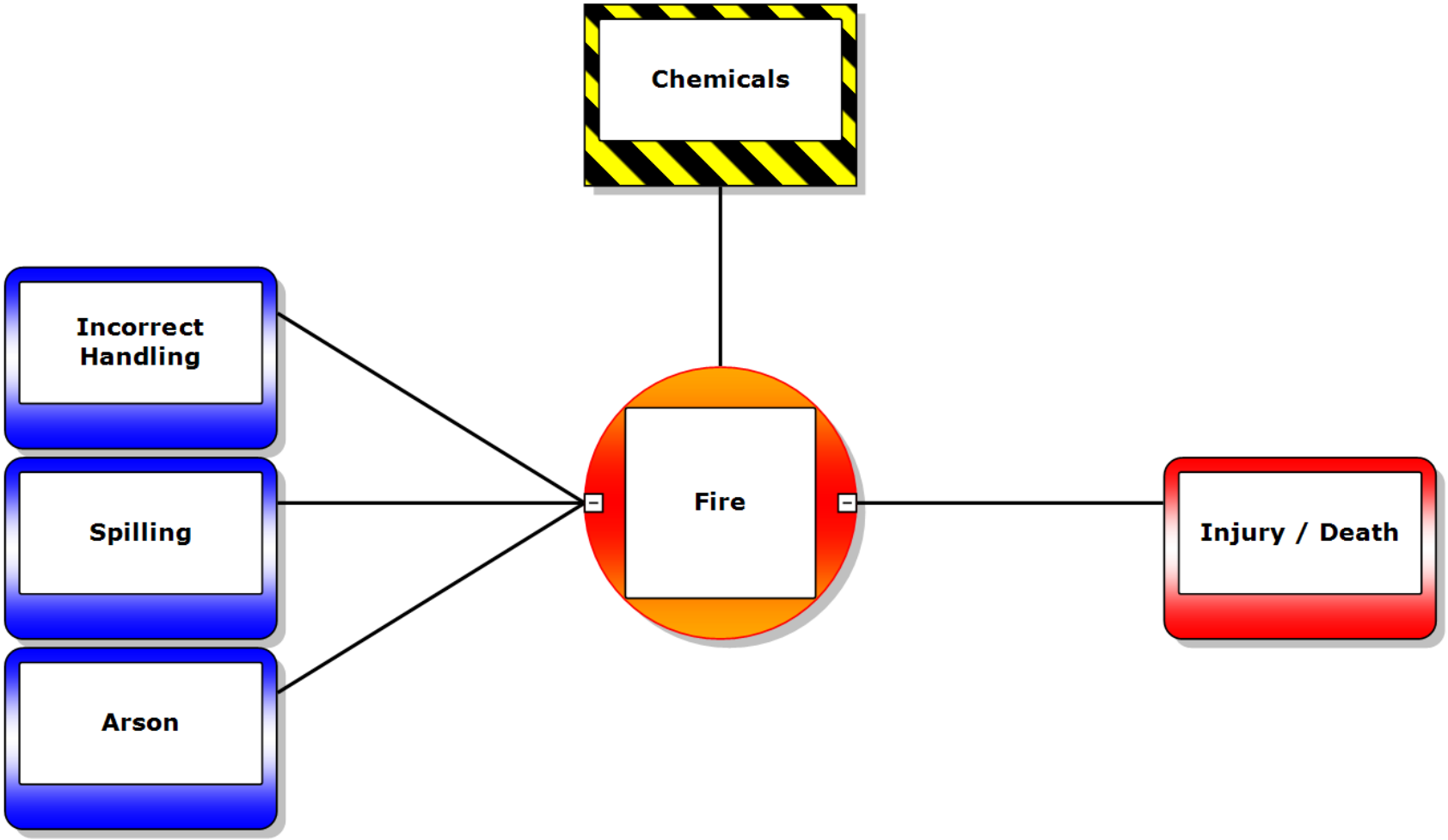


Corrected Bowtie

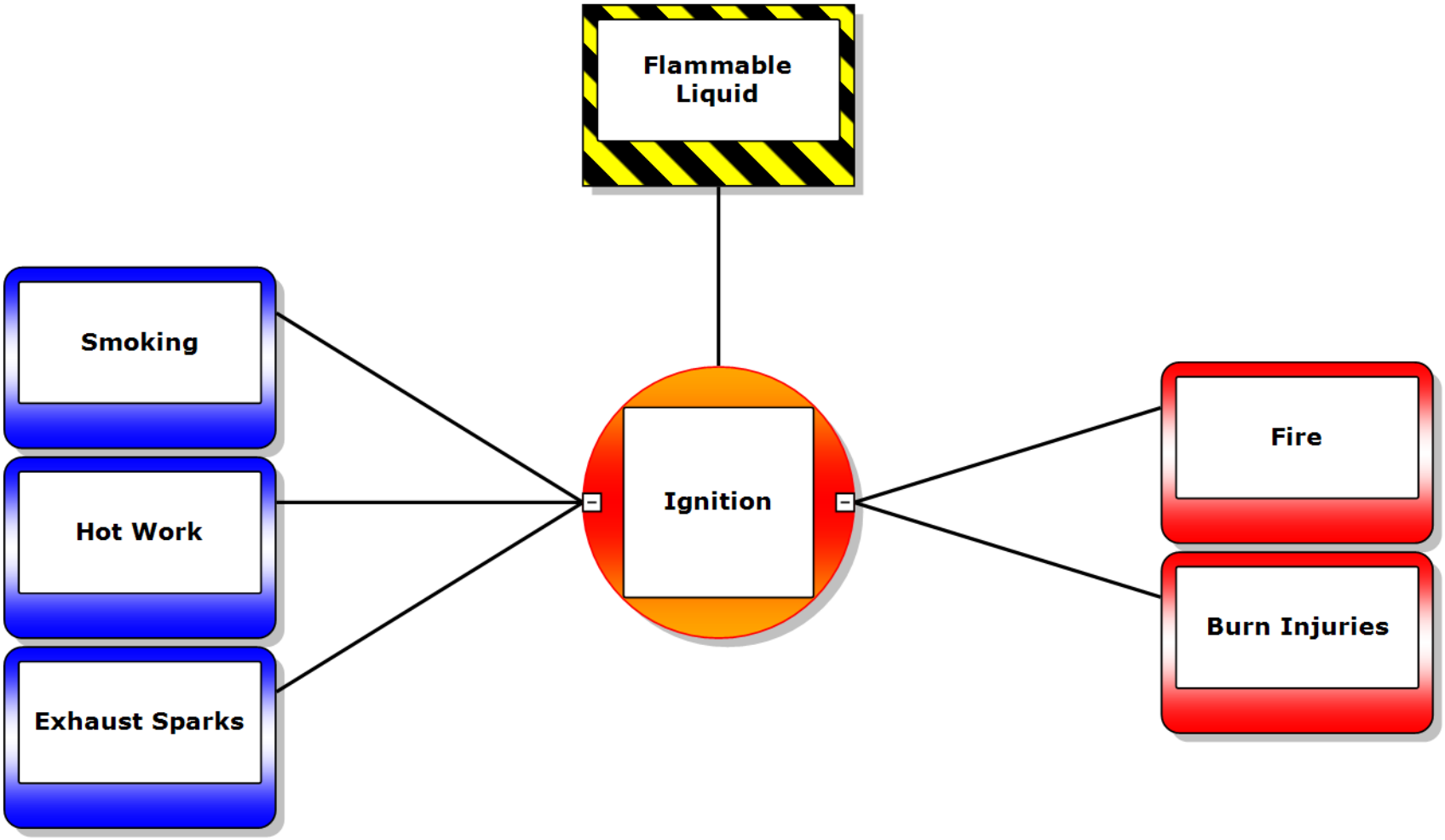
What is wrong with this Bowtie? - Chemical



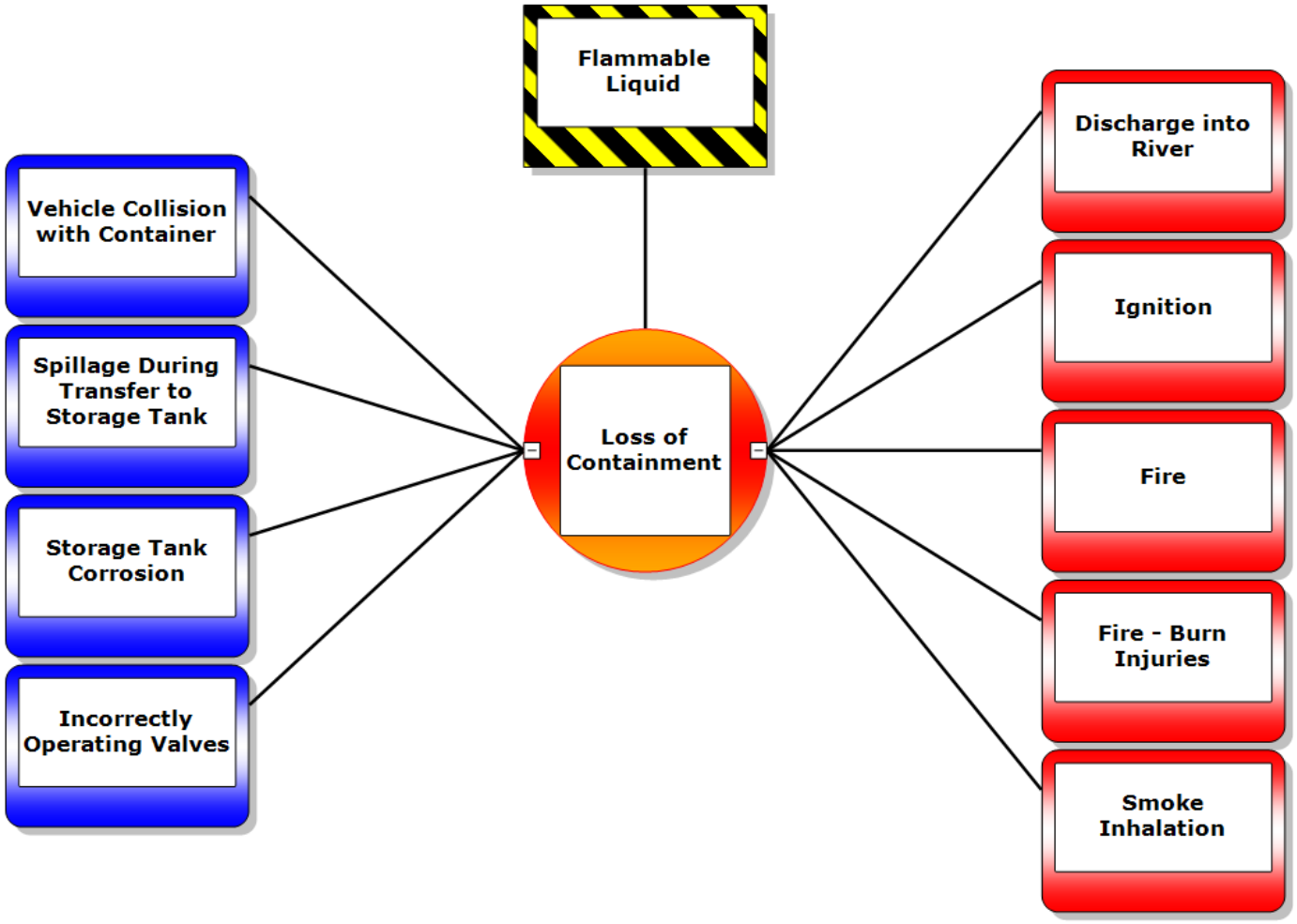
What is wrong with this Bowtie? - Chemical



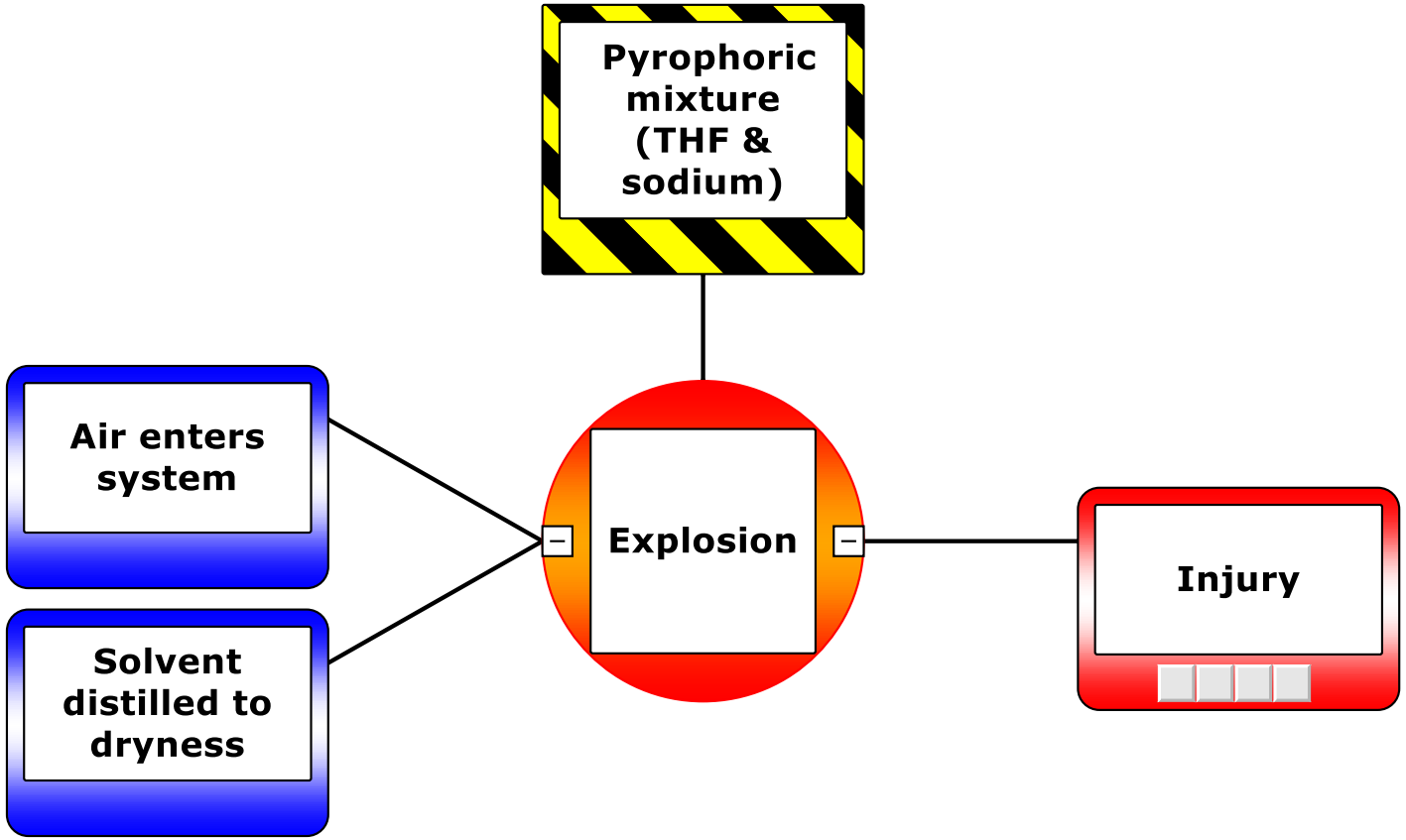
What is wrong with this Bowtie? - Chemical



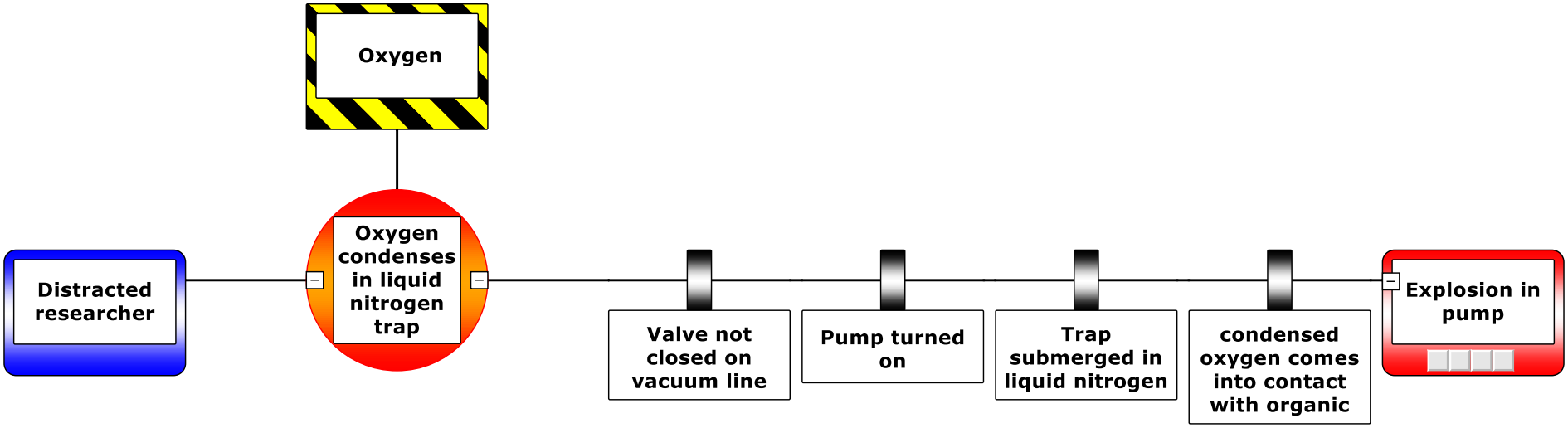
What is wrong with this Bowtie? - Chemical



What is wrong with this Bowtie? – Laboratory



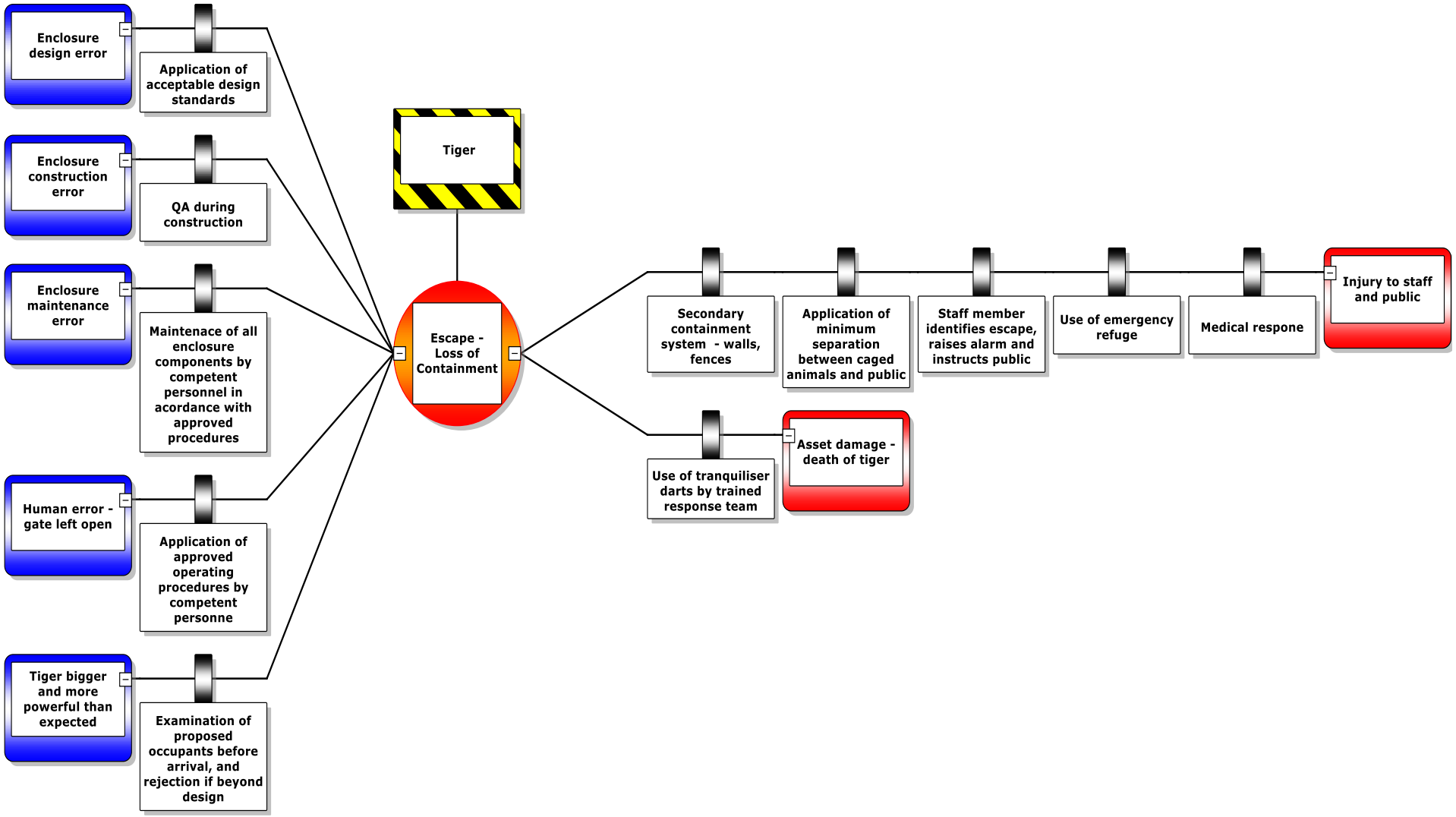
What is wrong with this Bowtie? – Laboratory



Next

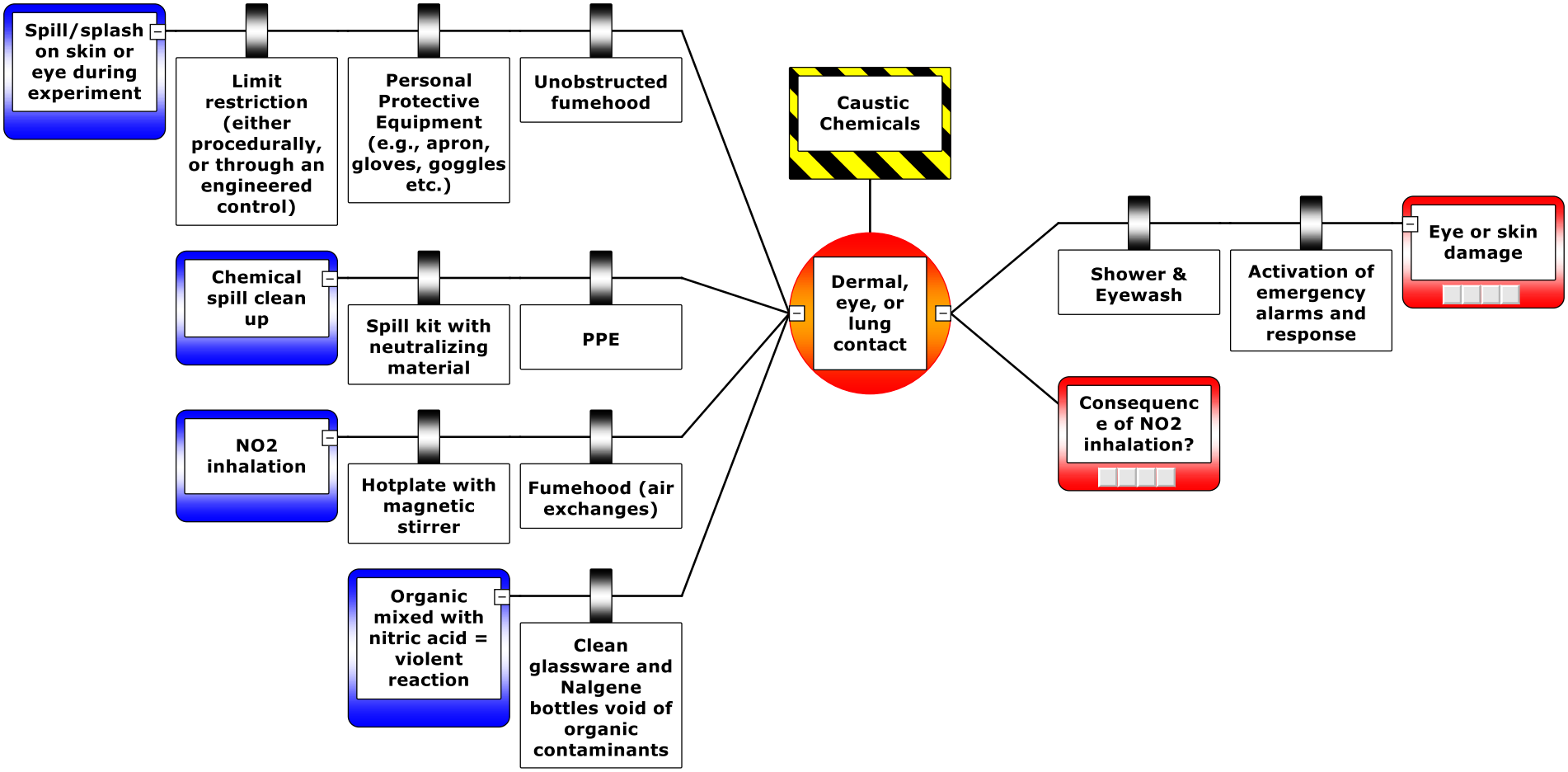
- **Group workshops**
  - Instructors will assign groups
  - 15mins to work on 1st exercise + 5mins class discussion
  - 30mins for 2nd exercise
  - Then review CSB investigation of laboratory incident and final group work

Exercise 1 – Example solution



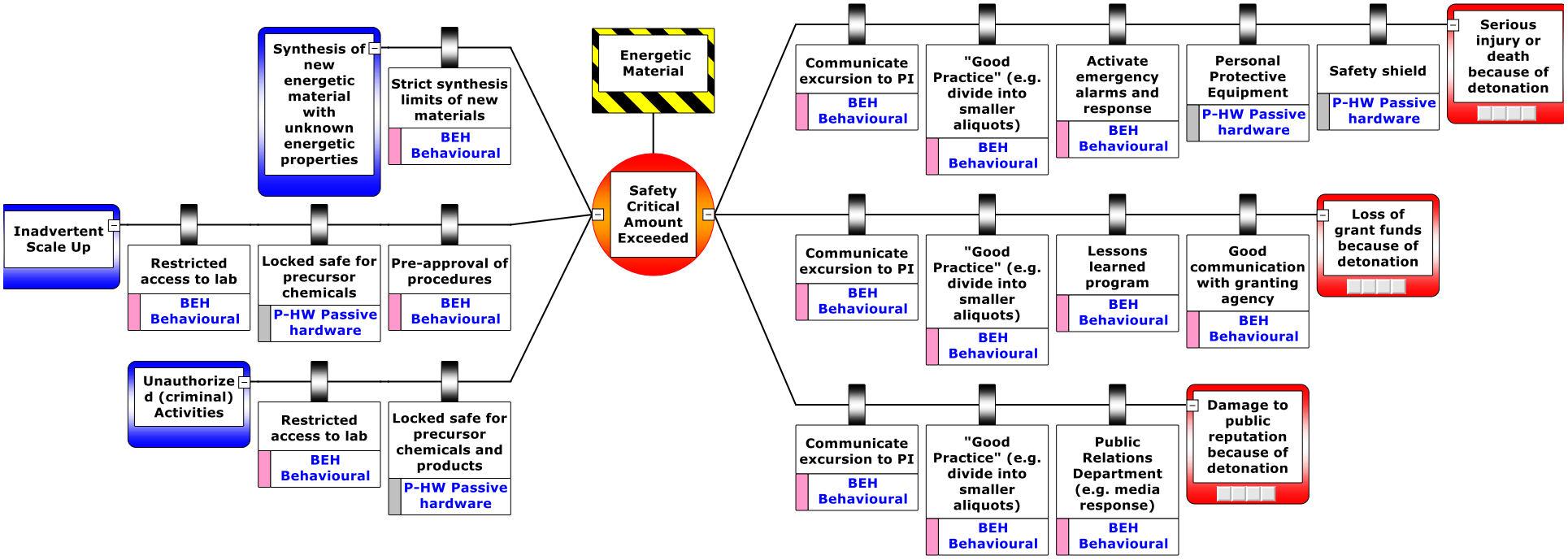
Exercise 2 – Copper Digestion

Exercise 2 – Example solution

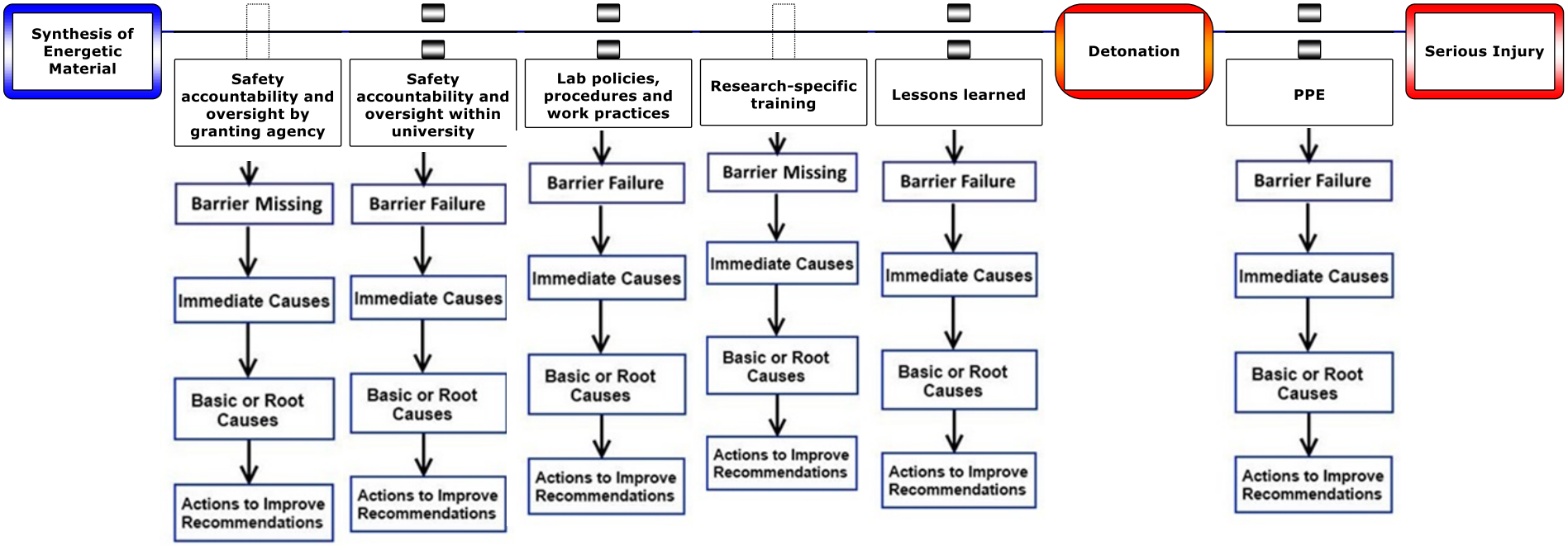


Exercise 3 – TTU Incident

Exercise 3 – Example TTU Solution



Exercise 3 – Example TTU Solution - Barrier Incident Diagram



Conclusions

End

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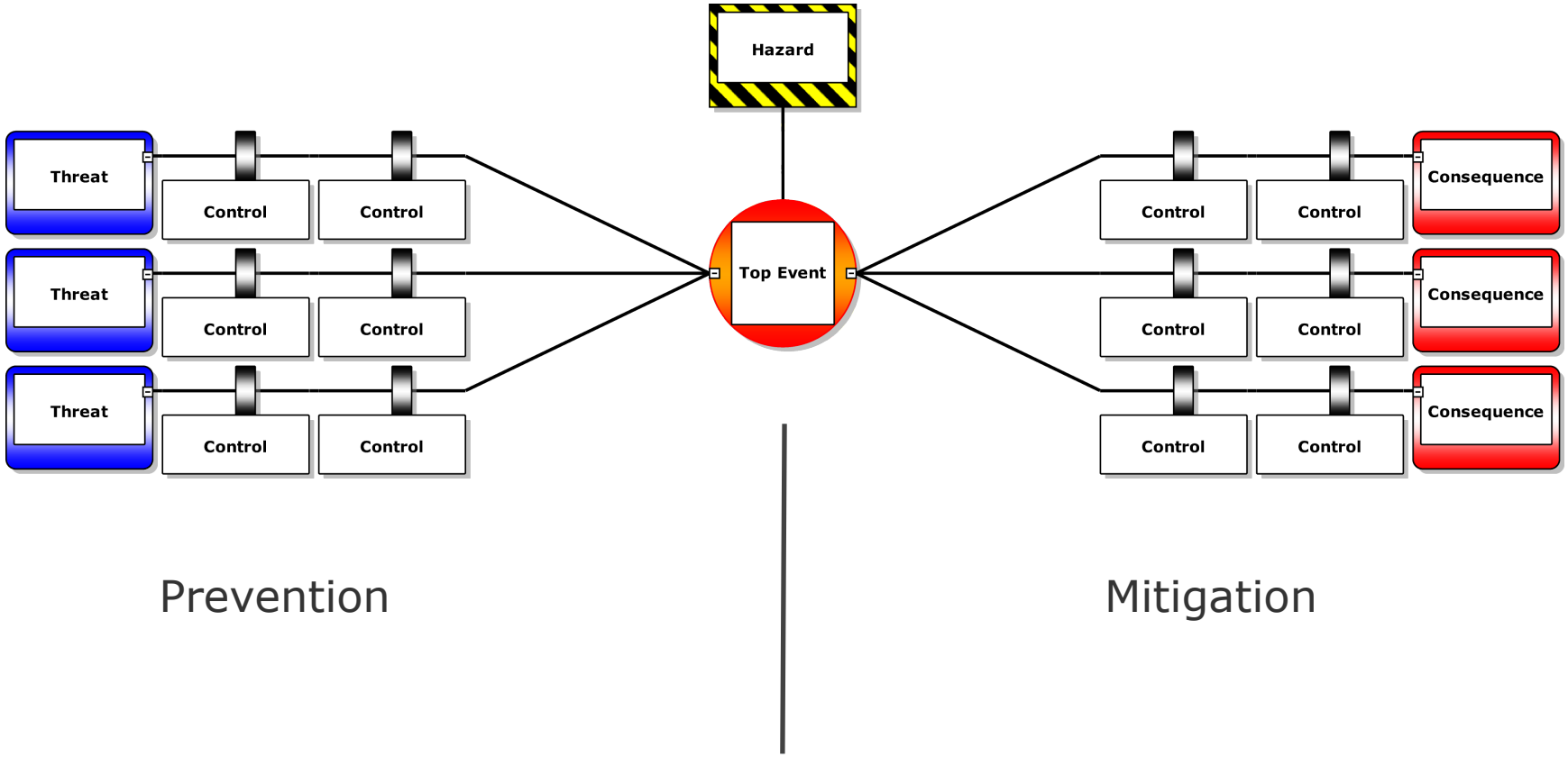
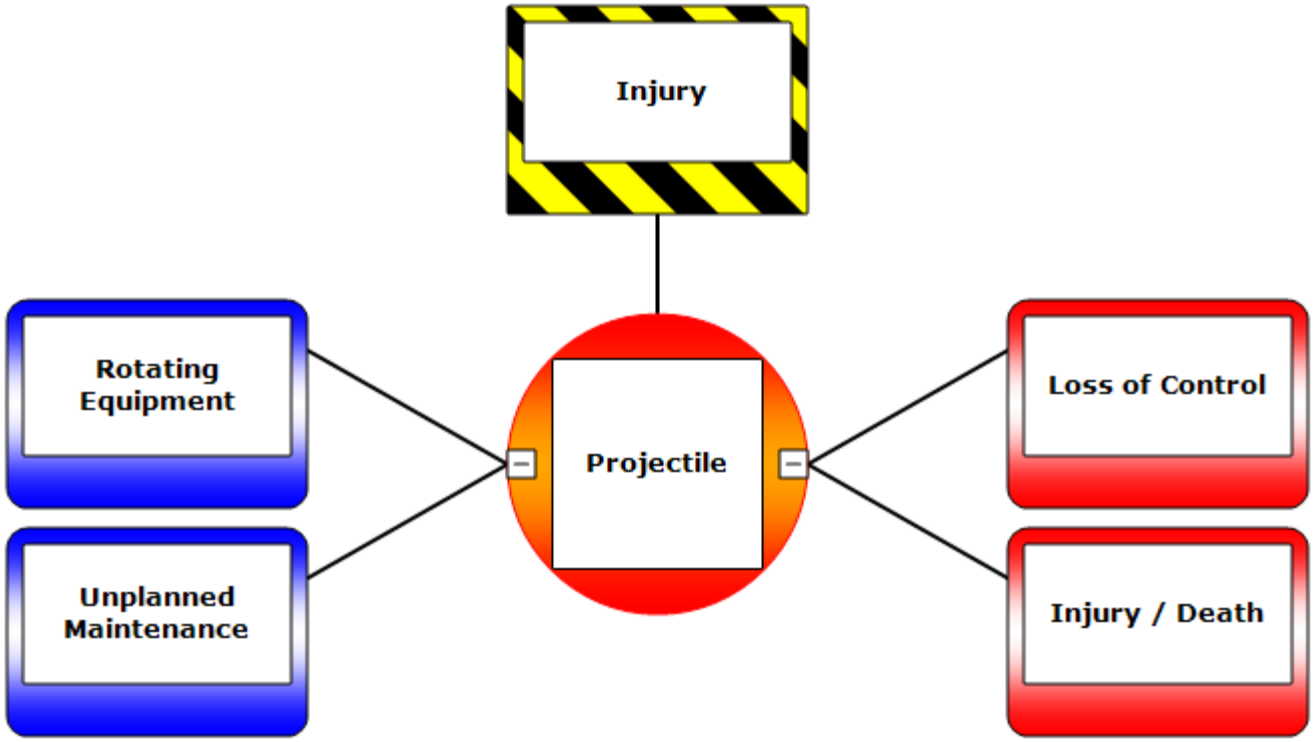
Bowtie Risk Model



What is wrong with this Bowtie? - Mechanical



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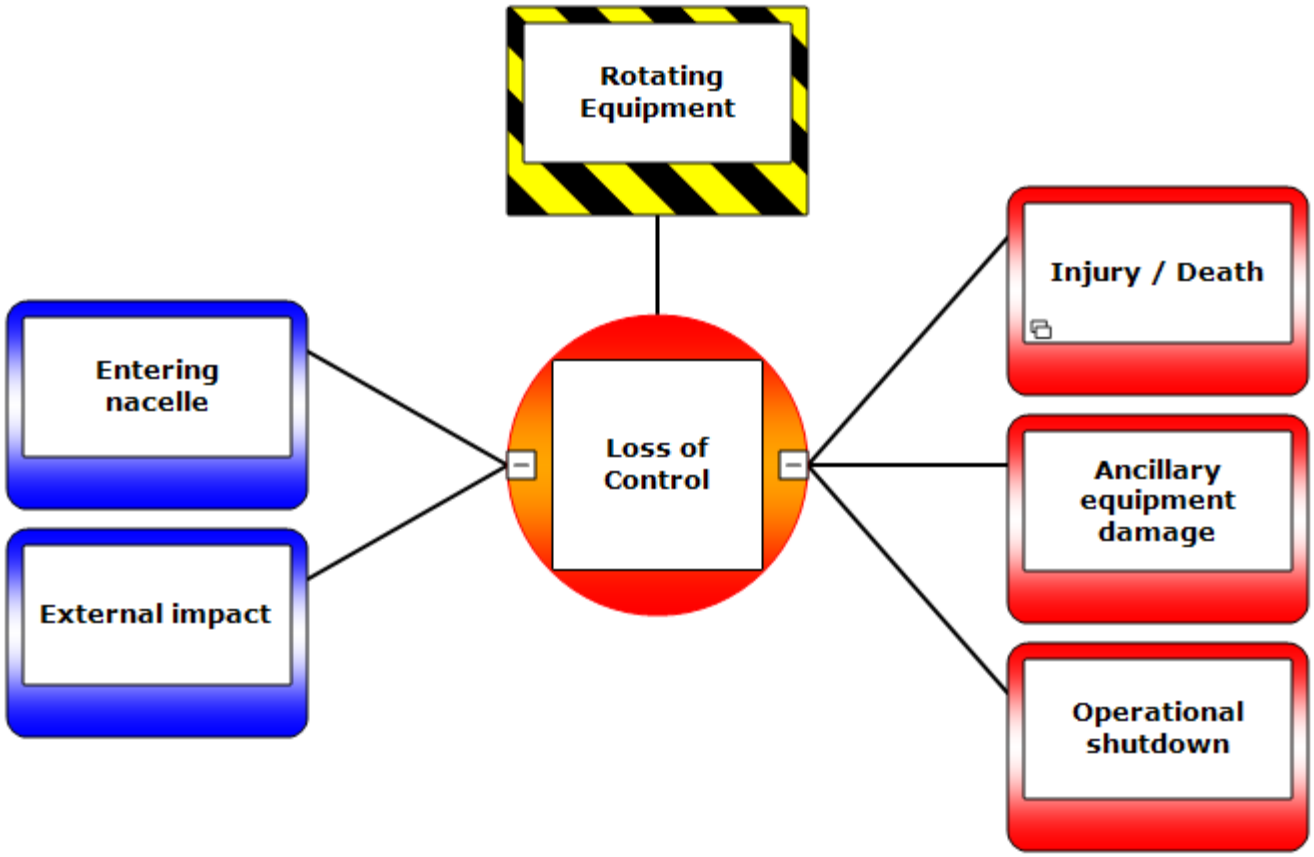
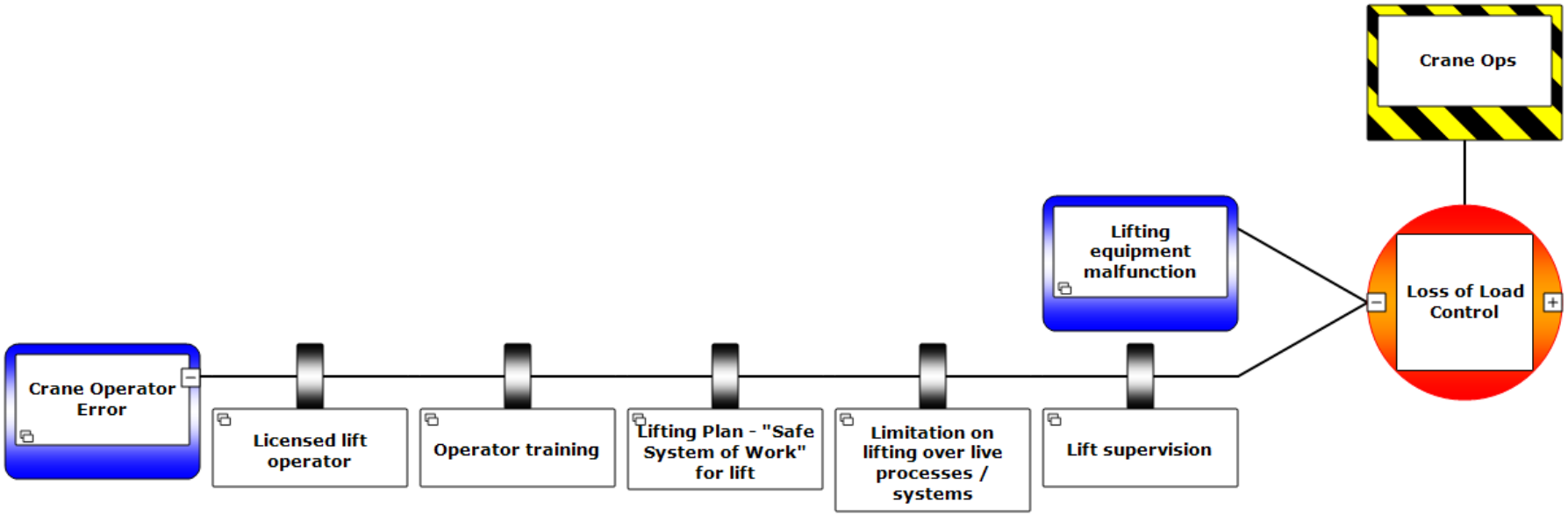


Crane Ops - Are these Controls independent?



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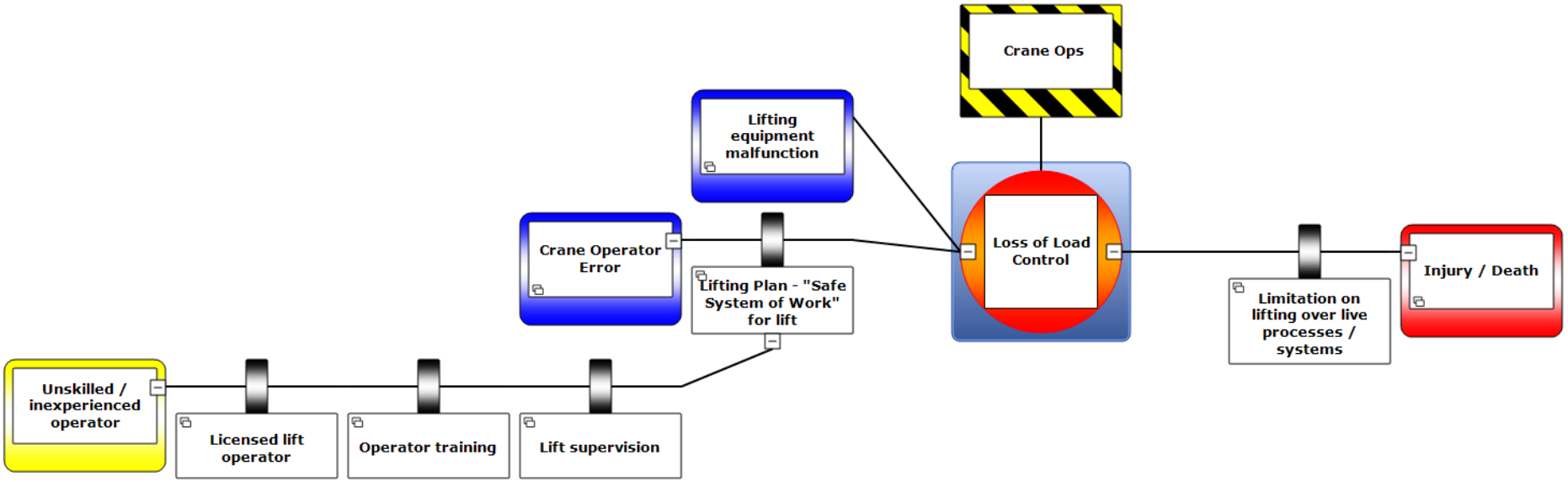
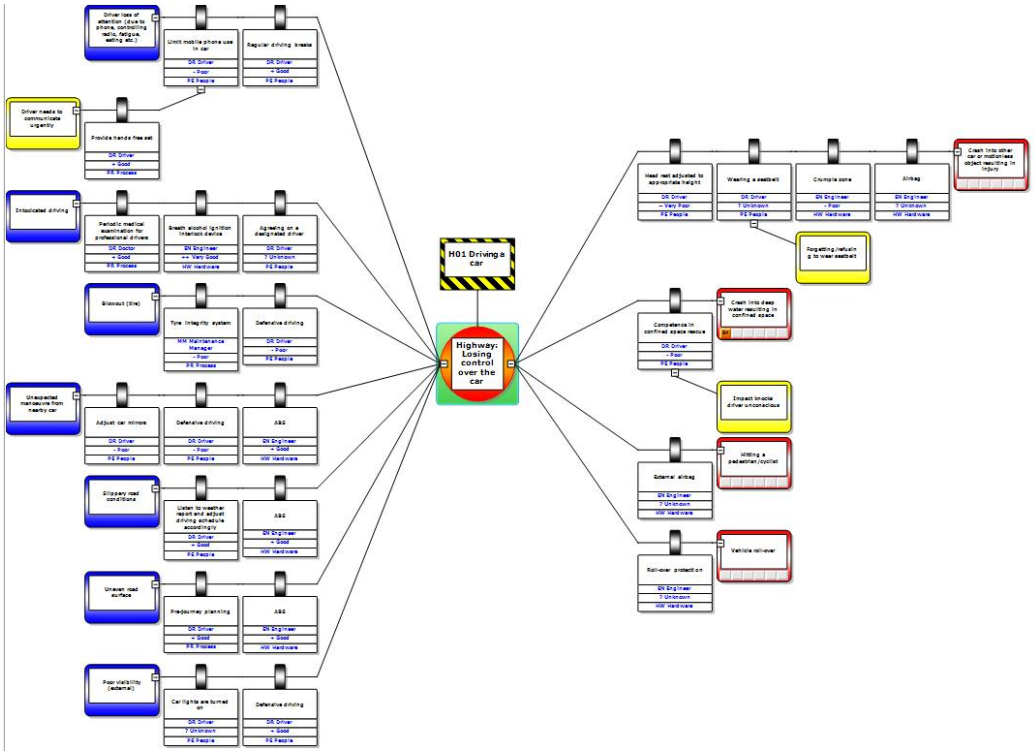


Bowtie Analysis – What it really looks like



- Large number of routes
- Large number of barriers
- Only some are critical
- Easier to analyze
- Easier to communicate

Bowtie Example - Driving Vehicle